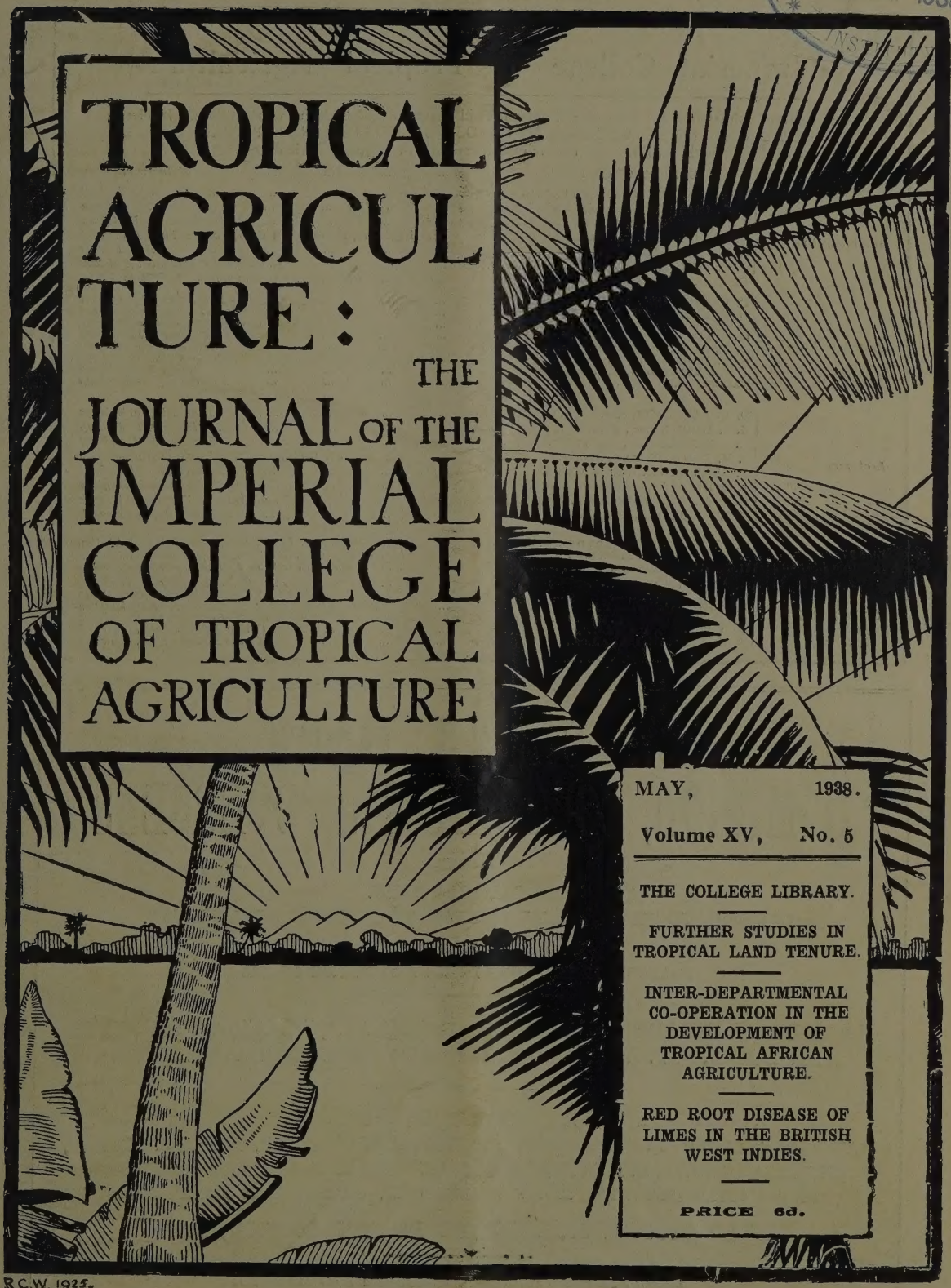
IMPERIAL MYCOLOGICAL INSTITUTE
7 MAY 1938

TROPICAL AGRICULTURE:

THE JOURNAL OF THE IMPERIAL COLLEGE OF TROPICAL AGRICULTURE



MAY, 1938.

Volume XV, No. 5

THE COLLEGE LIBRARY.

FURTHER STUDIES IN TROPICAL LAND TENURE.

INTER-DEPARTMENTAL CO-OPERATION IN THE DEVELOPMENT OF TROPICAL AFRICAN AGRICULTURE.

RED ROOT DISEASE OF LIMES IN THE BRITISH WEST INDIES.

PRICE 6d.

R.C.W. 1925.

Imperial College of Tropical Agriculture

THE College is situated at St. Augustine, Trinidad, amid beautiful and healthful surroundings. It offers a THREE-YEAR DIPLOMA COURSE AND POST-GRADUATE AND SPECIAL COURSES with facilities for research and training in Tropical Agriculture.

	ERIC MACFADYEN	*Chairman of Governors*
Administrative Staff	SIR GEOFFREY EVANS, C.I.E., M.A., Dip. Agric.	*Principal*
	G. G. GIANETTI, M.A. Dip. Agric. (Econ.)	*Dean*
	J. R. DICKSON, O.B.E., M.B., B.Sc., D.P.H.	*Medical and Health Officer*
	G. G. GIANETTI, M.A., Dip. Agric. (Econ.)	*Registrar, Editor of the College Journal and Librarian*
	G. R. LANGDALE, A.C.A.	*Bursar*
	C. T. WATTS, A.M.I.Mech.E., M.A.S. Ref. E.	*Engineer and Technical Assistant*
	DE L. H. A. CORBIN	*Chief Clerk and Manager of the Milner Hostel*
Professorial Staff	R. CECIL WOOD, M.A., Dip. Agric.	*Professor of Agriculture*
	E. E. CHEESMAN, M.Sc., A.R.C.S.	*Professor of Botany and Genetics*
	F. HARDY, M.A., Dip. Agric.	*Professor of Chemistry and Soil Science*
	C. Y. SHEPHARD, Ph.D., B.Sc. (Econ.)	*Carnegie Professor of Economics*
	A. M. ADAMSON, M.A., B.Sc., Ph.D. (Calif.)	*Reader in Entomology*
	R. E. D. BAKER, B.A., A.I.C.T.A.	*Lecturer in Mycology and Bacteriology—Officer-in-Charge*
	J. G. DAVIES, Dip. Agric., A.I.C.T.A.	*Sugar Technologist*
	VACANT	*Professor of Entomology*
Lecturers	D. D. PATERSON, B.Sc.	*Reader in Agriculture*
	K. S. DODDS, B.Sc., Ph.D.	*Lecturer in Botany*
	E. C. HUMPHRIES, B.Sc., Ph.D.	*Lecturer in Chemistry*
	S. H. CROWDY, B.Sc., A.R.C.S.	*Jr. Lecturer in Mycology and Bacteriology*
	E. McC. CALLAN, B.Sc., A.R.C.S.	*Lecturer in Entomology*
	J. R. DICKSON, O.B.E., M.B., B.Sc., D.P.H.	*Tropical Sanitation and Hygiene*
	H. V. M. METIVIER, O.B.E., B.Sc., M.R.C.V.S. (*Trinidad Dept. of Agr.*)	*Lecturer in Veterinary Science*
	F. W. COPE, B.Sc., A.R.C.S.	*Botanist, Cacao Research*
Low Temperature Research Station	C. W. WARDLAW, Ph.D., D.Sc., F.R.S.E.	*Officer-in-Charge, Low Temperature Research Station*
	E. R. LEONARD, M.Sc., B.Sc. A.R.C.S.	*Plant Physiologist, Low Temperature Research Station*
	H. R. BARNELL, M.A., Ph.D., B.Sc.	*Biochemist, Low Temperature Research Station*
Advisory Staff	G. A. JONES, Dip. Agr. (*Bangor*)	*Commissioner of Agriculture*
	C. C. SKEETE, B.A.	*Assistant Commissioner of Agriculture*
	J. B. HUTCHINSON, M.A.	*Cotton Adviser to the Commissioner of Agriculture*
	P. E. TURNER, M.Sc., F.I.C. (*Trin. Dept. of Agr.*)	*Adviser in Sugar-Cane Expts. to Comm. of Agriculture*
	F. A. SQUIRE, B.Sc., A.I.C T.A.	*Cotton Entomologist, attached*
	R. G. FENNAH, M.A., A.I.C.T.A. (*Seconded*)	*Citrus Entomologist, attached*

BARCLAYS BANK
(DOMINION, COLONIAL AND OVERSEAS)

Formerly

THE COLONIAL BANK.

BANKERS TO THE IMPERIAL COLLEGE OF TROPICAL AGRICULTURE.

BRANCHES IN THE WEST INDIES AND BRITISH GUIANA

ANTIGUA, BARBADOS, DOMINICA, GRENADA, JAMAICA, ST. KITTS, ST. LUCIA, ST. VINCENT, TRINIDAD, DEMERARA, BERBICE.

NEW YORK AGENCY, 120, BROADWAY.

OVER 400 BRANCHES IN SOUTH, EAST AND WEST AFRICA, EGYPT, SUDAN, PALESTINE, GIBRALTAR, MALTA, CYPRUS, MAURITIUS, LIVERPOOL, MANCHESTER, HAMBURG.

LONDON OFFICE (FOR WEST INDIAN BUSINESS), 29, GRACECHURCH STREET, E.C.3.

HEAD OFFICE: 54, LOMBARD STREET, LONDON, E.C.3.

BARCLAYS BANK (CANADA), MONTREAL AND TORONTO.

TROPICAL AGRICULTURE

THE OFFICIAL JOURNAL OF THE IMPERIAL COLLEGE OF TROPICAL AGRICULTURE

VOL. XV, No. 5 MAY, 1938 PRICE 6d.

CONTENTS.

	PAGE.
The College Library	97
Chemical Research in Hawaii	98
Further Studies in Tropical Land Tenure	99
Inter-Departmental Cooperation in the Development of Tropical African Agriculture	102
Sea Island Cotton in Florida	104
Red Root Disease of Limes in the British West Indies	105
Micro-organisms causing Fermentation Flavours in Barbados Molasses	109
Swollen Shoot of Cacao	110
Soil-less Horticulture	111
Experiment on the Hand collection of Egg-masses of Citrus Weevils (*Diaprepes* spp.) in St. Lucia	112
A Field Trial of Three Popular Green Manure Crops of Trinidad	114
Reviews	116
Sugar Notes	118
Chemical Notes	119
Trend of the Markets	120

THE IMPERIAL COLLEGE OF TROPICAL AGRICULTURE, TRINIDAD, B.W.I.

Cables :: "Stomata." | Phone :: 2183

TROPICAL AGRICULTURE is published monthly at the Imperial College of Tropical Agriculture, St. Augustine, Trinidad, West Indies. Advertisement and subscription rates can be obtained at the College from the Editor, or from the Secretary of the College, 14, Trinity Square, London, E.C. 3, England. The Editor will be glad to consider authoritative articles for publication. It is understood that opinions expressed or recommendations made in signed articles or in articles of which the source is named are those of the author and do not necessarily represent the policy or opinion of the College Authorities. Increasing numbers of inquiries are being received from the various parts of the tropics which can be answered only by persons possessed of an intimate knowledge of local conditions. Enquirers should first satisfy themselves that their local Department of Agriculture is not able to supply them with the desired information before communicating with us. Correspondence which will be replied to is invited on all other matters pertaining to tropical agriculture, science and development

THE COLLEGE LIBRARY.

"HE then took occasion to enlarge on the advantages of reading, and combated the idle, superficial notion that knowledge enough may be acquired in conversation. 'The foundation', said he, 'must be laid by reading. General principles must be had from books, which, however, must be brought to the test of real life . . . What is said upon a subject is to be gathered from a hundred people. The parts of a truth, which a man gets thus, are at such a distance from each other, that he never attains to a full view'." — (From Boswell's *Life of Samuel Johnson.*)

No one will deny that research, whether it be academic or utilitarian in outlook, needs for its development a basis of existing knowledge as wide and as deep as can be secured. The study of what is already known is the first step in discovering the unknown and in that study the research worker's chief source of knowledge is literature. Without the published facts relevant to his particular problems he could make but little progress. Thus, under modern conditions, a well equipped and adequately staffed library must be regarded as an essential feature of any large research centre. We have, in this respect, been fortunate in that our needs for adequate library facilities have not only been recognised but have also to a large extent been met.

The nucleus of the present library was acquired from the Imperial Department of Agriculture for the West Indies when its functions were taken over by the College. This represented a valuable collection housed originally in the old College buildings. In 1925 it was moved into the new buildings where it occupied several stacks of wooden shelving which served for some years as temporary accommodation. At that time, through lack of funds and staff, little could be done for the library. From 1927, however, with the help of substantial capital grants generously contributed by the Carnegie Corporation, the Empire Marketing Board and the Empire Cotton Growing Corporation, considerable re-organisation was possible. Not only was the collection of books re-classified and re-arranged but numerous bulletins, reports and pamphlets that had been accumulated in previous years were indexed and catalogued. Many text books and back sets of missing periodicals were purchased and an extensive binding programme carried out. The library was also enriched by the purchase of

publications belonging to various private collections and by a large number of donations. By 1930 it was obvious that more shelving space was required and the first five steel stacks were installed. In 1931 further accommodation was provided in the form of a double tier of 14 steel stacks with a glass floor, balustrades and staircase. The whole of this steel structure has greatly improved the appearance and efficiency of the library. In 1932, a magnificent endowment from the Carnegie Corporation of New York assured the permanent maintenance of our files of current periodicals. As a result of gifts and purchases the College library may now be ranked as one of the most comprehensive scientific libraries in the Colonial Empire. At the present time it contains well over 30,000 publications of which approximately half represents bound volumes. Some 500 periodicals of which a large proportion are exchanges, are filed. Although the collection is in the main purely scientific and includes chemical, agricultural, botanical, entomological, mycological and other technical literature, it also comprises sections on the history, economics and geography of tropical countries. The periodicals account for at least half the stock of bound volumes, the remainder consisting of monographs, text books, government reports, transactions of congresses, bibliographical works, and reference books of various kinds.

From humble beginnings the library has thus gradually developed into an indispensable integral part of the College. Besides catering for the needs of its students it also attempts to satisfy the growing demands of its research and teaching staff. While the needs of students are comparatively easy to meet those of the staff are often much more difficult and tax our resources to the utmost. The library is intended primarily for the use of members of the College but recently a number of outside readers have also used it for reference purposes. In this connection we are glad to have had the opportunity of helping persons from abroad who have repeatedly told us that they had selected the College as their headquarters partly on account of the library facilities which it provides. Visitors of this kind are always welcome and we hope to see many more of them in the future. It may also be of local interest to know that arrangements have recently been made to open the College library on one evening during each week for the benefit, in particular, of outside readers.

The cost of many of the text books, of binding and of providing shelving accommodation has been paid for in the past out of capital grants which are now unfortunately exhausted, and in future an allowance will have to be made from the general revenue of the College to meet the expenses incurred in this connection. This is a fitting occasion on which to record our deep appreciation of what the Carnegie Corporation, the Empire Cotton Growing Corporation and the Empire Marketing Board have done for our library. We have also to thank numerous publishers, government and private institutions, and private individuals, for the valuable assistance which they have extended at all times in helping to bring the library up to date. Without all this generous support it would have been impossible to build up to anything like its present degree of completeness the collection of publications that must be the backbone, if not the only constituent of any scientific library, nor would it have been possible to have taken steps to preserve our collection adequately, and to house it in surroundings worthy of its contents. As it is, the nucleus of what is essential for purposes of tropical agricultural teaching and research has been built up and will remain as a permanent and invaluable source of information to aid our activities.

Of late years the very considerable increase in the number of publications received has made heavy demands on the available shelving space in the library and further accommodation in this respect is now urgently required. If the library is to maintain its present scale of efficiency it will be necessary to keep its collection of text books up to date and to maintain, as hitherto, the binding programme. In the past the expenditure connected with these requirements has been met from capital grants, which, as we have already pointed out, are now exhausted. Thus, for the time being, the cost of any future expansion on the lines indicated will have to be borne by the College. It is to be hoped, however, that contributions from other sources will be forthcoming to meet this additional expenditure since the existing resources of the College are insufficient to cope with it.

CHEMICAL RESEARCH IN HAWAII.

The major portion of the 1936 Report of the Committee in charge of the Hawaiian Experiment Station deals with the methods for rapid estimation of certain constituents in soils and cane juices. Some interesting work is being done in connexion with the supply of nitrogen to the plant which has a bearing on certain aspects of the problem of nitrogen supply. It is noted that nitrogen added when the plant is most capable of absorbing and utilizing the nutrient appeared to favour increased yield, but, if withheld until growth was advanced, the plants were stunted and yields decreased. Time is, thus, an important factor in manurial tests and it is interesting to note that considerable attention is being paid to this aspect in the fertilizer trials.

Further information on the availability of insoluble phosphates is given and has a bearing on acid soils of high phosphate fixing capacity. Superphosphate applied to such acid soils yielded ten times the amount of millable cane obtained without phosphate in spite of the fact that the phosphate must have been fixed completely within a few days.—(*Int. Sugar Jr.*, Vol. XXXIX, No. 468, *p.* 459, 1937.)

FURTHER STUDIES IN TROPICAL LAND TENURE.

By H. M. Leake.

INTRODUCTION.

The primary function of any Government, next to the maintenance of internal and external security, is to assure to the population a sufficiency of the essentials of life. In the case of primitive races within the tropics, where nature renders the demand for shelter and clothing a minimum, the main essential is food. But, as the result of opening up the wilder areas of the world, of the contacts which such opening up has established between civilization and all but the wildest and most backward tribes, and of the dissemination of education, in the majority of cases the range of essentials is rapidly expanding. Former luxuries are becoming to be regarded as essentials if only, by way of illustration, it be the Indian peasant who formerly was contented to go bare-foot but now desires, first shoes and then an umbrella. Thus is being created a demand, and a growing demand, for manufactured goods, which can only be met by supplies from without. That is the individual demand, to fail to satisfy which, once it has arisen, means discontent; but it is not the only demand. The very process of opening up such countries, involving as it does material for railways, motors and such like, creates a communal demand which, again, can only be supplied from without.

These supplies must be paid for and, except in the case of those countries which are favoured with a wealth of minerals, the only method of payment lies, and will for long lie, in the export of agricultural produce. Though, therefore, the assurance of adequate locally raised food supplies must form the primary consideration of the Governments of such countries, the needs for the moral and material progress of the peoples, the trust imposed on these Governments, place on them the hardly less important function of ensuring an excess production of a magnitude which will meet the charges incurred on the imports required to meet both the communal and private needs. Unless such a balance is attained, progress will be checked. The major stimulus in the creation of desires is education; with it an ever increasing range of products passes from the field of luxury to that of essentials. Discontent will inevitably arise if too great an emphasis is laid upon education and desires are stimulated which have to remain unsatisfied through lack of a sufficient bulk of exportable agricultural produce. Education and development of such a surplus must proceed hand in hand or, if complete adjustment be not possible, education must lag behind development if a steady progress and content are to result.

Here is raised a further consideration; a large surplus available for export is not, in itself, sufficient. Such surplus must be of a quality which will find a market. No tropical country today has a monopoly of any agricultural produce. Of the majority of such products there is an ample, and often a super-abundant supply, and it is the market and not the producer who dictates what is, and what is not acceptable. This competition between countries is likely to remain for long the order of the day. Thus, quality in the exportable surplus is hardly less important than quantity.

The bulk of tropical agricultural produce is derived from plants—animal produce is of minor importance at the present time—and plants are living organisms responding to their surroundings. If quantity, high yields, is the primary objective of an improved standard of cultivation, it must not be overlooked that quality may be largely influenced by the conditions under which the crop is grown. Cotton, unless a high degree of purity is maintained in the seed supply, will not yield that uniformity of staple which will ensure a ready market; oranges must be free from blemish by insect or fungus, and numerous other instances occur readily to the mind. Nor is this all. Many agricultural products require to be processed and graded before reaching the market, and such processes, witness tobacco, cacao and palm oil, may involve technical control of no mean order if a constant, readily marketable product is to result. Lastly some products, particularly sugar, require an expensive outlay on plant to convert the product of the field into marketable goods. For this, capital is required and this capital will only be forthcoming if an assured supply of raw produce is guaranteed.

At the root of all such problems lies the system of land tenure, and any consideration of the various systems of tenure must take cognisance of this. The questions that have to be asked proceed in the following order; how far will any particular system assure the primary requirements of the population for food and, in the case of countries where these primary requirements have ceased to be the dominant issue, how far will they satisfy the requirements for the production of an adequate marketable surplus sufficient to pay for the imports which the advancing standard of life renders necessary to assure contentment?

In the more backward or more precarious tracts the primary consideration must be the assurance of an adequate locally produced food supply; but, unless councils of despair are to be adopted, it is necessary to look forward to the time when that assurance is sufficiently guarded. The time will then come when the organization of the surplus will become the necessary, and even the dominant consideration. It may well then be found that the system of tenure designed to meet the earlier dominant need is ill adapted to meet the later need. There is considerable danger that the problem in such tracts will be considered as a static one whereas it is dynamic.

In the more advanced tracts the problems take a dual aspect, largely as a consequence of history. On the one hand are those more sparsely populated tracts where, though the climatic conditions favour agricultural development, a too exuberant nature, disease, intertribal warfare, slave-raids and such like causes, have left a totally inadequate population. Here vacant lands are abundant and development has proceeded through alien agency. Such conditions are found in Fiji, Assam, Ceylon, Malaya and East Africa. That agency consists of large plantations worked by paid labour which is frequently imported. The tenure problem here, as far as such a problem exists, lies in the method of adjustment, as between Government and the holder of the land rights, of the incremental value of the land. The reclamation of such virgin lands involves not only considerable capital but risks and, in the early days of colonization, a free grant of land was the only method of attracting capital. At the present time these risks are much reduced, communal expenditure is adding to the value of the properties and capital is attracted by something less than a free grant of land.

In these cases sub-tenures are rarely granted, for the work of cultivation is normally carried out by paid labour. The system, however, raises important questions, particularly when that labour is recruited locally, as to the terms of contract. Freedom to bargain exists only in theory unless the labourer has some other form of employment which is only supplied when land is available on which he can return to settle. The problem of labour, thus, forms an integral part of any study of tenure for, if the plantation system forms the readiest means of producing an exportable and marketable surplus, it also raises the risk of building up a body of landless workers held to the industry by lack of alternative means of finding a livelihood. Where labour is recruited from abroad, such problems hardly arise but no less difficult problems may be created in the country of recruitment if large bodies of labourers are turned adrift. The conditions in South India and the East generally are sufficiently flexible for such problems to solve themselves but in certain West Indian islands the sudden deportation of masses of labour from Cuba has raised the question of their disposal in acute form. A similar kind of problem is found also in some of the West Indian islands where the labouring population is formed of the descendants of slaves or of indentured labour which has taken up permanent residence in the island.

On the other hand, are those more densely populated countries in which, owing to the density of the population itself, combined with that fuller recognition of native rights which has characterized colonial policy in recent years, all available land lies in some degree of recognized ownership and there is no unclaimed land on which large scale production after the plantation pattern is possible. Examples of such are Uganda and the more fertile tracts of West Africa and, with these, may be linked the areas of the East African colonies which are reserved to the native, and may be generally termed native lands. In these, policy, rather than economic considerations, have dominated the course of development. The land is here held in trust for the native and progress is sought in the gradual evolution from the indigenous system of native tenure. Complex and varied as those systems are, they have a common basis or origin in tribal ownership with individual possession. With a growing density of population, a sense of land-consciousness is developing which lays increasing emphasis on the idea of personal ownership and most of the variations of indigenous tenure may be interpreted as expressions of that consciousness. Native tenure, thus, is not a static condition; it exhibits an evolutionary trend, which, though subject to minor variations, is in the direction of individual ownership of small holdings. Its goal is a peasant system in the fullest sense. It is an admirable system where alternative fields of employment are lacking and where the primary consideration is the assurance of an adequate food supply. But it is a pertinent question to ask whether it is an equally admirable system for producing that bulk of marketable surplus produce which the rising standard of living demands. It may well be that policy and economic considerations here part company and the dangers of such a divergence are obvious. While a growing contact with the outside world combined with educational advancement is stimulating desires previously not realised and only to be satisfied by imported goods, the corresponding means for supplying those goods may not be forthcoming. Thus are sown the seeds of discontent.

There remains to be considered a third system, the plan of which is founded less on the conditions of climate and population than on conceptions of Government. It is the system that prevails over a large part of India where it is best exemplified. It arises from the conception, which has a religious basis, of a tax on productive capacity of the land. The Sacred Law, or Dharma, of the pre-Moghul days laid down the maximum demand for the use of the land as one third of the produce. A similar conception, with again a religious foundation traceable in the Mosaic Law and crystallized in the Qoran was brought from the North and developed in India by the Moghuls. This conception, like the former, envisaged a direct relation between State and peasant and fixed the demand at one-tenth, the tithe or ushur, and its influence is to be found outside India wherever Mohammedanism has dominated. But India was a large country and only partly unified under the Moghuls. A direct relationship was impossible and a system of collectors of land revenue, determined on the productive capacity of the land, was evolved for the fully controlled areas, in which the collectors were officials of the State. In the less fully controlled areas this system was replaced by a fixed demand,

theoretically representative of the land tax. To meet the cost of the highly centralized Government, the tax was raised to 90 per cent. of the gross produce. With the decline of the Moghul dynasty the detailed surveys which formed the basis on which the revenue was determined, gave place to the simpler practice of farming out the revenues. With growing influence proportionate to the decline of the central authority these farmers had, by the time of the British occupation, assumed most of the characteristics of landlords and, during the early period of this occupation, intermittent attempts were made to graft the English system with its landlord and tenant on to the indigenous system. Largely through a misconception, these farmers of revenue, approximating so closely to the English landlord, were accepted as such and thus arose that system, so widespread throughout especially northern India, of landlord (zemindar) paying land revenue to the State based on the productive capacity of the land and tenant (ra'yat*) paying rent to the landlord. Here, again, the question arises how far the system is capable of producing a marketable surplus; and, if practical experience offers little evidence as to its potentialities in this direction, the reason is to be found in the conditions prevailing in India. India is a large country with a teeming population and immense natural resources. If the mass of these peoples are simple peasants, there is not lacking a sufficient body of cultured and wealthy individuals naturally skilled in trade and progressive in outlook. Here are the elements, capital, labour and raw materials for an industrial development of no mean order. Technical skill, hitherto lacking, has been introduced from without and is rapidly being acquired. That development is fast gathering momentum. To a large and growing extent India is becoming a consumer of her own agricultural surplus and a supplier of those manufactured goods which are required to satisfy the desires called forth by a rising standard of living and even of the communal demand for heavy goods. The competitive value of her surplus in the world's markets plays a minor part.

In the preceding discussion emphasis has been laid on the reaction of the land tenure system as aiding or retarding the progress of the peoples towards a higher standard of living. Essential to that progress, but not synonymous with it, for questions of distribution are involved, is a growing wealth of the community as a whole. Most of the countries here considered have started on their voyage of progress under British guidance prior to the great war. Up to that time two forces were at work. On the one hand, the industrial development of the nineteenth century created a growing demand for raw materials. Thus the market was generally unsaturated with the result that quantity took precedence of quality. It was only necessary to produce and the market would absorb. It was a trend which received a violent stimulus during the course of the war. On the other hand, the opening up of these countries, combined with cheap facilities for transport, created a contact with the world's market which necessitated the adjustment of local to world prices. Both trends acted as a stimulus to production and had their reaction on the tenure systems. In those parts of India which were temporarily settled, the demands for an expanding revenue were largely met, for each settlement produced an increased assessment. The major problems here raised concerned the equitable adjustment of rents. Difficulties of another nature arose in the permanently settled tracts where this source of revenue was not capable of expansion, and later concerned more particularly the assessment of the contribution of the Local Government to Imperial revenues under the Montagu-Chelmsford reform scheme. In the countries more recently opened up, large extensions were made to the acreage under cultivation particularly of such crops as rubber in Malaya and cacao in West Africa.

With the termination of the war, a sharp contraction of demand occurred. This culminated in the world slump of the early thirties of which one of the most severe symptoms was acute agricultural depression owing to the fall in price of the primary products of agriculture. The tropical cultivator now found himself unable to sell his produce at a price which would enable him to continue to purchase those luxuries to which he had grown accustomed, even if he could find a market for it at all. It is not surprising that in view of the divergent opinions still held as to the fundamental causes of the slump, he should fail to realize the position, grow discontented and express his discontent in the simplest manner open to him, a refusal to pay his dues.

In the earlier series of these Studies* an account was given of the evolution and status of the very divergent systems of land tenure in the tropical countries incorporated in the British Empire.

Those studies described the various systems as evolved during a period of generally rising values for produce and of growing incremental values for the land itself. The effect of the slump was, at the time of writing, only beginning to be apparent. The present series covers both the time of depression and of the partial recovery of more recent date. Not the least point of interest is the resilience of the various systems to these adverse conditions.

(*To be continued.*)

* Sometimes spelt raiyat or ryot. The word has a wider significance, being applied also to the small holder whose rights are derived directly from the State.

* *Tropical Agriculture*, Vol. IX, Nos. 8-12, (1932); Vol. X, Nos. 1-6, (1933).

NOTICE.

THE EDITOR is prepared to purchase copies of Vol. XIV, No. 1, January, 1937, at the rate of 1*s.* per copy.

INTER-DEPARTMENTAL CO-OPERATION IN THE DEVELOPMENT OF TROPICAL AFRICAN AGRICULTURE.

By S. F. Deck.
(*Late Provincial Commissioner, Kenya Colony.*)

It is only during the last 15 years or so that the various Colonial Governments have put agricultural improvement definitely in the forefront of their efforts to raise the African standard of living. There is no need here for more than a passing reference to the reports of the various Commissions and Committees which have dealt with the subject since the Phelps Stokes Commission to South and East Africa started the ball rolling in 1924. Sir Daniel Hall's book "The Improvement of Native Agriculture in Relation to Population and Public Health", which should be carefully studied, states the case for this new policy clearly and comprehensively. It is difficult for the newly appointed agricultural officer (referred to hereafter as the A.O.), who has pursued his studies in civilized countries to visualise his future work, and the difficulties connected therewith, in our tropical African dependencies. Throughout his training his attention has been focussed on the scientific, rather than on the human side, of the agricultural problem. In the more backward districts of Africa today, it is the human side which is the more important. As Sir Daniel Hall remarks: "It is less research that is needed than the organization of a chain of instructors and demonstrators".

Consequently, when the A.O. is finally transported to the middle of Africa amongst "new men, new faces, other minds", he will find himself faced with a side of the agricultural problem with which he is probably unfamiliar. He will be well advised at the outset to realize four fundamental facts:—

(i) "The need of the African is training upon the land and in the workshop rather than in the school" (Sir D. Hall). (ii) The economic progress of the African cannot be properly achieved by any one department working by itself. (iii) The art of dealing with the human factor, *i.e.*, the African masses, can only be acquired by each individual officer in his own way by the exercise of much patience, sympathy and understanding, and by learning the language of the common people. (iv) African peasants are always inclined to play off one department against another and, by pleading contradictory instructions from different departments, to absolve themselves from the responsibility of carrying out any instructions at all.

This human factor, *i.e.*, the indigenous African population, varies very greatly in character and attainments. This article is directed to the problem of dealing with the more primitive type who is still under the sway of superstition, tribal custom and taboos.

Until a few years ago, it was considered that the activities of medical, educational and agricultural officers in the tropical African dependencies were entirely independent of each other, with the result that each department worked in a more or less water-tight compartment. The results in terms of agricultural progress were, needless to say, negligible. The voice of the A.O. was that of one crying in the wilderness: the administrative staff was not always in sympathy with his efforts, and the mass of the people, steeped in their age-old traditional ideas of agriculture, either regarded him as a misguided fool, or, if his efforts produced spectacular results, as an expert in White Man's Magic, which might be suitable for Europeans, but certainly not for them. Many of the tribes were degenerate and despondent communities, the prey, for countless generations, of hookworm, yaws or endemic malaria. Some are in this condition still. But during the last ten years, a new spirit has begun to move over the stagnant waters of Africa. Departmental isolation has gone by the board. Agriculture, education, public health and veterinary services now work as one team under the co-ordinating authority of the district administrative officer (hereafter called the D.C.). His title changes with bewildering rapidity, but he is always known to the African masses as "D.C.". His job is to achieve, by the harmonious co-operation of the various departmental officers working in his district, what isolated effort failed to do in the past, however brilliant the individual effort may have been. As a result of this "New Deal" a steady wave of progress is now discernible, where before, only spasmodic ripples were to be seen.

In certain territories, where this co-operative effort has achieved visible and remarkable results in a comparatively short time, the newly-appointed A.O. may be somewhat bewildered by the large and varied assortment of institutions at work on agricultural development. In a progressive and thickly populated district, he will probably find the following:—

(i) The A.O.'s experimental station. (ii) The local African council's seed farm where seed, proved on (i), is grown in large quantities for distribution throughout the district. These farms sometimes comprise hundreds of acres and contain model small holdings, which can be taken up by selected peasants working under the guidance of the A.O. (iii) An agricultural school, run by the A.O., mainly for training agricultural field staff and agricultural instructors. (iv) A central district school, run by the education department, where agriculture usually forms part of the curriculum. In most of these there are extensive school gardens,

for which the A.O. usually supplies instructors from his own school (No. i). (v) Numerous elementary schools, also with gardens attached, under the control of the education department or of missionary societies. (vi) A prison farm, run by the D.C. as superintendent of the prison. This is a very useful institution. The primitive African is seldom a person of criminal instincts, as understood in civilized communities. As often as not, he finds himself in gaol for taking the law into his own hands to settle a personal grievance in the traditional tribal manner, and is frequently a person of energy and enterprise. To him work on the prison farm comes as a relief from the monotony of prison life; and, free from the distracting influence of tribal festivities and ceremonies, he can give his undivided attention to improving his knowledge of agriculture. (vii) Small holder settlements where a planned and balanced agriculture is carried on by selected Africans trained at (i) or (ii). (viii) Special agricultural courses for chiefs and headmen run by the A.O.

These institutions represent what may be called the direct effort towards agricultural improvement, and, as far as the agricultural work is concerned, are all under the supervision of the A.O.

At present these institutions deal directly with only a small fraction of the population. Various other activities directly affecting the bulk of the peasant population, but less directly concerned with agriculture, are of the greatest importance in the general scheme of agricultural improvement amongst the masses. For example, sanitary inspectors, working under the medical department can be of great assistance to the A.O. They are primarily concerned with the disposal of rubbish and excreta round the villages and with the improvement of housing conditions and water supplies. But they can be, and frequently are, active apostles of the gospel of composting. This is a matter of vital importance in all districts, but especially in those where density of population has created a land shortage, and where the grazing grounds are remote from the villages. Some inspectors become expert in the lay-out of model holdings, and as they suffer less from servitude to the office stool than the average departmental officer, they have ample opportunity for exercising the personal touch which is of such vital importance in gaining the goodwill of the masses. The A.O. will find in this gentleman a most useful co-adjutor.

In some districts, little progress can be made with the agricultural programme without a medical clean-up. Hookworm, yaws and endemic malaria, &c., may have devitalized the people to such an extent that they are too apathetic to take any interest in anything. A sympathetic and energetic M.O. can work wonders in preparing the way for the A.O. The forestry department also has an important part to play in the general plan. Owing to the highly eroded condition of some of the African territories and the destruction of forests along watersheds, permanent large-scale agricultural improvement is impossible until a certain amount of re-afforestation has taken place.

The A.O. in these cases may have to bide his time before proceeding to make the "desert blossom as the rose". The forest officer will, for the time being, need all the assistance he can get from every one as African district councils usually have the strongest objection to re-afforestation. They will grant land for agricultural experiment and demonstration, for seed farms and small holding schemes; but to get land for re-afforestation is almost as hard as getting blood out of a stone. The African community, which has for many generations expended much effort in destroying forest to provide grazing lands for livestock, cannot for the life of it see why the efforts of its ancestors should be brought to nought by re-afforestation, even though the herbage from the hill sides has almost entirely disappeared. It knows too, that once the hills have been re-afforested, they will be protected by Government and that the beloved goats will know them no more.

Close co-operation between the A.O. and the district veterinary officer is also of the greatest importance. In some districts, the erosion caused by excessive livestock is a serious obstacle in the path of agricultural progress. African social status is usually based on the ownership of livestock, and compulsory reduction of the herds is a most unpopular business. The big stock-owners are the most influential people in the district; and their goodwill and co-operation are essential to the success of any large-scale agricultural improvement. Incessant propaganda by all departments concerned will be essential for some time to come to render the compulsory reduction of livestock acceptable.

The A.O. will also find himself in contact from time to time with various birds of passage, such as marketing officers (usually attached to the agricultural department), peripatetic cinema lecturers and officers investigating the possibilities of African co-operative societies.

The marketing of produce is controlled to a certain extent in most districts; and since the establishment of market centres and the introduction of inspection of produce prior to sale for export, the value of African native exports has increased appreciably. The A.O. will do well to study closely the subject of marketing and advise the D.C. of any improvement in the system which he may be able to think out: a new road, a new form of transport, *e.g.*, pack donkeys instead of head porterage or a new marketing centre, may make all the difference to the popularity of a new crop.

The D.C. is the key man of the whole business of African development. His job is to co-ordinate the activities of every departmental officer in his district. To quote Sir Daniel Hall again: "For the improvement of native agriculture, the machinery consists in the main of the agricultural staff maintained by each Government and of the

administrative officers living in the reserves (*i.e.*, African territories)" and again, "The main propaganda towards improvement must rest with the administrative staff", *i.e.*, the D.C. and his assistants. In the more backward African territories the D.C. is regarded by chiefs and people as the most important and influential person in the district. He is usually the principal magistrate. He is head of the executive staff for the maintenance of law and order. All instructions to chiefs and headmen must be approved by him and issued through him. All payments to the African administrative staff are made through his office and are subject to his approval. He holds the keys of the treasury and of the gaol. He is, above all, Chairman of the local district council, a body which, with the increasing funds at its disposal, is beginning to realize the meaning of the old political phrase "the power of the purse". This local district council, sometimes known as the local native council or the local native authority, is, in its present form, an institution of recent growth designed to give the African some idea of the duties and responsibilities of representative Government. The members are usually elected from the elders of the district and meet about four times a year. In some districts, there is a hereditary chief with councillors, who hold their position either by virtue of heredity or of native custom. The Council, of which the President is usually the D.C., can impose rates and introduce bye-laws. Its funds are derived (i) from grants made to it by the colonial government, (ii) from rates imposed by the council, (iii) from rents and royalties payable by concessionaires in the district.

Funds for agriculture, education, public health, &c., are provided partly by the Central Government and partly, and to an increasing extent, by the African district councils.

The Council's estimates of revenue and expenditure are prepared by the D.C., and are kept entirely separate from the ordinary Colonial estimates. Considerable sums are voted annually for the improvement of agriculture, for education and for public health. It is obvious therefore that an inter-departmental tug-of-war is possible unless the D.C. can obtain unanimity amongst the various officers of the district as to the order of precedence of the various schemes of development put forward. This is usually decided at periodical meetings of all departmental officers in the district, under the chairmanship of the D.C. The general feeling of the local district council on the subject is also taken from time to time; and the A.O. and other officers are generally called upon to explain to the council the proposals they have in mind. By the time the estimates are due for submission to the council, the various schemes have been well considered and a decision as to precedence has usually been reached. No scheme of development involving expenditure from the funds of the council should be recommended by any departmental officer to the people of the district, until it has been approved at the D.C.'s meeting for inclusion in the annual estimates. But once it has been approved, no opportunity should be lost of explaining and recommending the scheme to the people on every possible occasion. Delay frequently occurs in the execution of a useful project through lack of understanding on the part of the masses. Personal contacts with individual cultivators are most essential to the success of any project of agricultural development. The goodwill of the people must be gained. "One volunteer is worth many pressed men"; and though official propaganda to chiefs and headmen is better left to the D.C., the converts made by the A.O. to the cause of better agriculture by dint of explanation and demonstration, generally lay the foundation of success.

Harmonious co-operation between departments is not easily achieved. After the burden and heat of the day in tropical Africa, tempers easily get frayed, and the team occasionally finds itself at sixes and sevens. Especially is this apt to be the case when the heads of the various departments at headquarters do not see eye to eye. But men working with goodwill in a good cause can generally achieve unanimity after the release of a certain amount of steam, first at the district meeting, and subsequently, if the pressure of feeling is still too high, at the meeting of all departmental officers in the province held periodically, under the chairmanship of the provincial commissioner.

It is well to remember that good team work is essentially a matter of give and take, and that personal feelings and opinions must occasionally be subordinated to ensure successful collaboration in the common cause.

SEA ISLAND COTTON IN FLORIDA.

According to the 1937 Report of the Chief of the Bureau of Plant Industry, there has been a considerable revival of interest in sea island cotton in the United States as a result of better yields and good prices for the fibre. In 1936 about 3,500 acres in Florida and Georgia produced 900 bales, which sold at prices ranging from 27 to 33 cents a pound. More than 15,000 acres were planted to sea island cotton in Georgia and Florida in 1937. In order that the purity of the seed stocks may be preserved for a sustained production of high-quality fibre, the Bureau is co-operating with State agencies in Florida and Georgia in assisting growers to organize themselves into communities growing sea island cotton exclusively.

Hybrids between sea island and extra long-staple upland cottons are being produced experimentally in the hope of developing varieties combining the long, silky fibre of sea island with the greater productiveness, larger bolls, and earlier maturity of upland. In 1936 the F1 generation from a large number of selected crosses from the preceding year was grown. These hybrids were backcrossed to one or both parents in 1936, laboratory studies were made during the winter, and desirable stocks were sorted out and planted in 1937.

RED ROOT DISEASE OF LIMES IN THE BRITISH WEST INDIES.

By R. E. D. Baker, B.A., A.I.C.T.A.
(*Mycology Department, Imperial College of Tropical Agriculture.*)

Introduction.

Sphaerostilbe repens, Bk. and Br., the fungus thought to be the cause of red root disease of the lime, has been known in the British West Indies for many years. It was first recorded by South (10) from Dominica in 1912, and later by Nowell (8) from the same island. Both these workers regarded the fungus as one of the causes of root disease of limes, and thought that it was probably of less importance than the black root disease caused by *Rosellinia* spp. *Sphaerostilbe repens* has been known in Trinidad for some years, being described by Stell (11) as the cause of the death of 'Immortelle' trees (*Erythrina* spp.) on swampy, low lying lands; and has been found by the author on a dying *Cassia javanica* tree in 1934, and more recently on a dying seedling lime tree. The same fungus was found on limes in St. Lucia in 1933, and again on limes in Montserrat in 1936. It is also known to occur on various crops including tea and rubber in Ceylon (9), Malaya (5) and Assam (12), and an identical or closely allied species has been described from Jamaica and British Guiana.

Three destructive outbreaks of red root disease of limes have occurred in the British West Indies—Dominica 1927, Montserrat 1933, and St. Lucia 1934. In all three instances the majority of the seedling lime trees on both good and poor soils were killed in about four years from the outbreak of the disease.

Although it is now over ten years since the outbreak of red root disease in this destructive form occurred in Dominica, the status of *Sphaerostilbe repens* as a dangerous primary parasite is still in doubt, and the factors which render lime trees liable to red root disease are still little known. It is proposed in this article to summarise the present extent of our knowledge of red root disease in the West Indies and to make certain recommendations for the future.

The Dominica Outbreak.

The first report of a serious outbreak was made by Harcourt (7) in July 1927 who reported that root disease had become widespread and noted that conditions in 1926 and 1927 had been peculiarly favourable for its development. He thought that it was due to the reduction in vitality of the trees caused by withertip (*Gloeosporium limetticolum*) and by the 1926 hurricane, which was followed by the semi-abandonment of cultivation, and the consequent inability of the impoverished owners to control root diseases. Briton-Jones (4) visited Dominica in August 1927, and from his observations arrived at the conclusion that *Sphaerostilbe repens* was not a primary parasite. He considered that the predisposing factors to this disease were of great importance, and amongst others laid stress on the effect of floods, hurricanes, wither-tip, damage to roots by insect grubs, and the poor agricultural methods obtaining at the time. He suggested that Dominica planters should look to the cultivation of their remaining seedling fields, and should in future plant trees budded on the sour orange stock. This measure has met with considerable success and some excellent fields of budded limes have been established. The question of the benefits gained by budding limes on to other stocks is examined in a later section of this article. In 1929 Ashby (1) visited Dominica and also concluded that *Sphaerostilbe repens* was not an actively parasitic fungus, and that the 1926 hurricane, followed by the protracted wet season of 1927, and later the 1928 hurricane, had so damaged the trees that they had succumbed readily to the attack of a weakly parasitic fungus.

It is evident, therefore, that there is no lack of predisposing factors to the disease in the case of the Dominica outbreak, and the explanation of the death of old seedling trees based on these assumptions made by Briton-Jones (4) and Ashby (1) seems to be well substantiated. The causes of the outbreaks in Montserrat and St. Lucia are, however, less evident.

The Montserrat Outbreak.

In Montserrat, limes are grown under very different conditions from those obtaining in Dominica. The soils are mainly light, the rainfall considerably lower, and most areas are very windswept. The larger citrus fruits are hardly grown at all and conditions must be near the borderline for successful lime cultivation. Ever since the inception of the industry scale insects and dieback have been serious problems, an indication that the climate is probably too dry for the trees during much of the year. The trouble now attributed to red root disease started in 1934, and in April 1934 Briant (3) visited the island and made the first report on it. He found neither *Sphaerostilbe repens* nor *Rosellinia* spp. nor any other obviously parasitic fungi, and concluded that the disease was caused by death of roots due to lack of drainage in the wet season, followed by drought in the dry season, and the consequent death of branches. By April 1936 the affected area had spread and it became obvious that Briant's (3) explanation was not entirely satisfactory. The author (2) visited the island in April 1936, and came to the conclusion that the citrus weevils (*Diaprepes* spp., which damage the cortex of the roots) were responsible for most of the trouble. *Sphaerostilbe repens* was found, but in negligible quantities. By September 1937 the trouble had spread yet further and Fennah (6) concluded that the citrus weevils were not there in sufficient numbers to have caused all the damage, that a physiological or ecological explanation was unlikely, and that the trouble must either be due to *Sphaerostilbe repens* (which he found in considerable quantities on dead trees) behaving as an active parasite, or to a hitherto

unidentified fungus. Since the conclusions of these three workers are so different, it is evident that the death of seedling limes in Montserrat requires further investigation from all aspects. A phenomenon which has occurred in Dominica, Montserrat and St. Lucia and which has never been explained satisfactorily is the rapid death of seedling 'supplies' planted in fields where the old trees have died of red root disease. This may have been caused by the attack of citrus weevils, or by an abundance of active *Sphaerostilbe repens* in such fields, but here again further investigation is obviously desirable. Possible predisposing factors to red root disease in Montserrat therefore probably include drought, wind, scale insects, and citrus weevils. The old lime plantations were almost entirely destroyed by the hurricanes of 1925 and 1928, and the existing fields, which were planted since 1928, have never been damaged by hurricanes.

The St. Lucia Outbreak.

The most recent of the three outbreaks of red root disease occurred in St. Lucia. In November 1934 the disease was reported on a few trees in the Soufrière valley, on an area which had been damaged by floods the previous year. It was found at the time that although adjoining trees were dying from the attacks of citrus weevils and from bad drainage they did not show *Sphaerostilbe repens*. The evidence is strong therefore that the trees which did show *Sphaerostilbe repens* had been similarly affected before they were attacked by the fungus. A survey made after the discovery of red root disease at Soufrière showed that the fungus was present in all the important lime growing areas in the island and that in all probability it had been there for some years. During 1935, 1936 and 1937 the disease spread with alarming rapidity at Soufrière, and by the end of 1937 most of the old seedling trees on the valley bottom had died. Most of the hillside fields have survived and the disease has not broken out in other parts of the island in spite of the universal presence of the fungus. At the present time, there is reason to believe that this rapid failure of the old trees may have ceased temporarily, though it is probable that the old fields on the hillsides can only last for a few more years. Part of the devastated area has been replanted with budded limes, none of which is more than three years old, and those which have not been damaged by the citrus weevils are making satisfactory progress. The St. Lucia lime cultivations have never experienced a hurricane, and predisposing factors to red root disease probably include citrus weevils, over-shading, drought and floods. There can be little doubt that the damage done to citrus trees in St. Lucia by the citrus weevils is serious, probably more so than it is in the other islands, and they must be regarded as a major factor in bringing about the death of the trees. One of the most noticeable features of the root-systems of old seedling trees is the lack of clean undamaged roots; they are nearly always scarred, knotted and twisted, and it seems probable that much of this damage has been caused by the larvae of the citrus weevils. After the introduction of wither-tip into the island many lime fields were planted with shade trees (Immortelles, Glyricidia, &c.) in an attempt to control the disease, but it is now evident that the shade has become far too dense, and has consequently done damage to the trees, both in forcing them upwards and in competing with their roots for the available soil, with a consequent fall in yield. On some estates reduction of shade and improvement of drainage has effected a remarkable improvement in the condition of the lime trees, and their yields have been materially increased.

Trinidad.

The writer has recently found *Sphaerostilbe repens* on a dead seedling lime tree in a field of trees at least 30 years old on poorly drained soil. This is the first record of the fungus on the lime in Trinidad, though it is well known on other plants. There has never been a serious outbreak of red root disease such as have occurred in Dominica, Montserrat and St. Lucia, although many estates have fields of old seedling lime trees which appear to be just as subject to the disease as the trees which have died out in the other islands. Most of the predisposing factors to the disease which have been described for the other islands have applied at one time or another in Trinidad, with the notable exception of the citrus weevils which have never been found in the island. It is probable that *Sphaerostilbe repens* is widely distributed in Trinidad soils, and it remains to be seen whether Trinidad limes will always remain free from the disease, or whether a serious outbreak will occur here just as has happened elsewhere.

Investigations in St. Lucia.

The writer recently paid a visit to St. Lucia to study red root disease in the Soufrière area and elsewhere, and certain interesting conclusions have been reached as a result of this work. Attempts were made to ascertain if any other primary fungus parasites were concerned in the disease, to assess the amount of damage done by *Sphaerostilbe repens*, and to find out the predisposing factors for the disease.

The fungus *Sphaerostilbe repens* is very easy to recognise in the field by its rhizomorphs, which are found on the surface of living and dead roots, embedded in the cortex of dead roots, and in between the cortex and the wood of dead and dying roots. It is probable also, though it has never been proved, that this fungus is able to live saprophytically on dead plant material in the soil. It is known to be a common saprophyte on the roots of dead trees, which have obviously died for other reasons, and it cannot be too strongly emphasised that the presence of *Sphaerostilbe repens* on the roots of a dead tree is not proof that the tree died of red root disease.

In the course of the investigations some 60 trees were dug up and their root-systems examined. The results obtained from the examination of 44 dead and dying seedling trees are summarised in Table I.

Table I.

Locality.	Age of tree in years.	Number of Trees.		
		Sphaerostilbe repens present.		*Sphaerostilbe repens* absent.
		Considerable.	Negligible.	
Soufrière Estate	5-10	0	2	6
Do. ...	25-30	2	5	0
Other Estates in Soufrière Area	5-15	1	1	3
Do. ...	25-30	5	1	1
Corinth ...	5-10	0	1	1
Do. ...	25-30	1	2	3
Marquis ...	5-15	1	1	3
Bosquet D'Or	15-25	0	2	2
Total		10	15	19

The results here summarised call for some comment. Of the 44 seedling trees of ages ranging between five and 30 years, all of which were at least half dead, 19 (43 per cent.) showed no trace of *Sphaerostilbe repens*. Of the 25 on which the fungus was present, 15 (34 per cent.) only showed traces of the fungus on dead roots which must have died for some other reason, and only ten (23 per cent.) showed the fungus in any quantity. There was a considerable amount of the fungus around the collar of each of these ten trees, and there was evidence that it was attacking or had recently attacked living tissues, and had been to some extent responsible for the death of the tree. It is noteworthy that trees of this type were found not only in the Soufrière area, but also in other areas where the presence of red root disease was not suspected. It is evident therefore that factors other than *Sphaerostilbe repens* are operating in bringing about the failure of seedling lime trees in St. Lucia.

In the short time available for the work as many isolations as possible were made from diseased tissues. The following results require confirmation, but until this is forthcoming they may be accepted tentatively. Firstly, no other parasitic fungi were found in advance of *Sphaerostilbe repens*, or in dead roots not attacked by *Sphaerostilbe repens*. Secondly, indications were obtained that at the junction of healthy and diseased tissues in roots there was often no fungus present at all, but that if isolations were made from a short distance into the dead tissues *Fusarium* species and *Botryodiplodia theobromae* were obtained, indicating that the roots had died for some other reason and were being invaded by saprophytes. Thirdly, isolations were made from living rhizomorphs of *Sphaerostilbe repens* in order to demonstrate that the fungus can readily be cultured, and from the tissues immediately adjoining them. No difficulty was experienced in obtaining the fungus in pure culture from rhizomorphs, but it was not found in the tissues immediately adjoining their tips. This observation is of value in that it means that the young rhizomorphs constitute the foremost part of the advancing fungus, and the extent of the fungus in a root can be estimated in field work by noting the distribution of the rhizomorphs, most of which lie between the cortex and the wood, thus considerably facilitating the examination of large numbers of specimens. The presence of the fungus in a dead root can also often be recognised by the bright red conidial fructifications on the surface of the root. It was impossible in the time available to carry out any inoculation experiments with *Sphaerostilbe repens*, but the conclusion reached from these investigations is that although this fungus may behave as a parasite under certain conditions it is more often found as a saprophyte. Other factors predisposing the seedling lime trees to attack by *Sphaerostilbe repens* are of more importance than the damage done by the fungus itself. A fuller knowledge of these 'other factors' is of considerable importance to the lime industry of the British West Indies.

Budded *versus* Seedling Trees.

After the 1927 outbreak of red root disease in Dominica, Briton-Jones (4) strongly advised that all future plantings of limes in that island should be made with trees budded on the sour orange stock. Where his advice has been followed excellent fields of budded limes have been established. The sour orange was recommended as a stock for limes for several reasons. Firstly, it is resistant to red root disease and gummosis, to both of which other stocks such as the rough lemon are susceptible. Secondly, it has a deeper root-system than the seedling tree and is therefore less liable to be blown down by hurricanes. Thirdly, the sour orange and lime tissues unite readily and form a good 'bud-union'; and lastly if budded trees are used instead of seedlings it is possible to exercise some selection in choosing budwood and a more uniform stand of trees can be obtained. The sour orange has, however, certain disadvantages. In Trinidad, where it is largely used as a stock for grapefruit, it is subject to a destructive root-rot, the cause of which is still unexplained. The roots die, the foliage turns yellow and falls, and sooner or later the tree dies. A few instances of partial recovery have been observed. Waterlogging, soil deficiency and 'off-type' stocks have been suggested as possible reasons for the disease, but nothing definite has been proved so far. In St. Lucia recently the stocks of some 200 budded lime trees were found to be attacked, some seriously, by gummosis. This is a serious disease to which the sour orange is normally resistant, but it is possible that under certain conditions it may lose its resistance to this disease, or that certain strains of the sour orange may be less resistant to the disease than others. Unfortunately, other citrus varieties,

especially the 'bitter-sweet' or 'sweet-Seville' orange are very similar in appearance to the true sour orange and are not resistant to gummosis. It is therefore possible that in this instance the outbreak has been caused by the limes having been budded on the wrong stock, but here again it is obvious that an investigation of the relative merits of the different stocks is very necessary. In Montserrat, limes are grown under drier conditions than they are in Dominica, St. Lucia and Trinidad; there is little risk therefore of gummosis and it is possible that some other stock may give better results than the sour orange, or even that seedling trees may prove more successful, in spite of their susceptibility to red root disease. For example, in areas where citrus weevil damage is severe, Fennah (6) has shown that young seedlings can tolerate heavy attack by citrus weevils for a longer period than can budded material of equal age. The experiment recently laid down in Montserrat to test the relative values of the sour orange, rough lemon and bitter-sweet orange as stocks for limes should be of considerable interest in this connection. Until these problems have been solved the safest policy for all lime growers in the West Indies is to plant trees budded on the true sour orange, taking great care to ensure that all the seed used in growing the stocks comes from known sour orange trees and not from bitter-sweet orange trees. Buying extracted seed is a very unwise practice since sour orange seed is indistinguishable from that of the bitter-sweet and the common sweet oranges with which it is easily adulterated.

The Citrus Weevil Problem.

It is impossible to discuss lime root diseases without mentioning the citrus weevils (*Diaprepes* spp.). One or more species is present in St. Lucia, Dominica and Montserrat, but they do not occur in Trinidad. The larvae of these insects damage citrus trees by feeding on the cortex of the roots, and, if a sufficient number of the insects is present the trees may be severely weakened or killed. Young trees are more easily damaged than older ones as a small number of weevil larvae is able to do serious damage to the root system of a young tree, while unless a large number of larvae congregate under the crown, an old tree is less easily damaged. The investigation of this pest is at present in the hands of Mr. R. G. Fennah, a full account of whose work in St. Lucia will be found in his latest report (6).

The weevils attack both seedling and budded lime trees, and there is no doubt that both types of tree may be killed outright by weevils alone, when the latter are sufficiently abundant, as they are in the northern parts of St. Lucia. Also, in instances where they do not kill the trees, there can be little doubt that they may weaken them severely, and render them more susceptible to the attacks of fungus diseases such as *Sphaerostilbe repens*. The actual amount of damage done by the weevil larvae is difficult to estimate even on young trees, and it is impossible to say what effect they have had on old trees which have been attacked and have recovered several times. Mr. Fennah's collaboration is of great value to a mycologist or plant physiologist investigating lime root diseases in these islands, and the author wishes to express his indebtedness to Mr. Fennah for his invaluable help given during his last visit to St. Lucia.

Discussion.

It is evident therefore that the root diseases of citrus, and especially those of the sour orange and the West Indian lime require further investigation. The status of *Sphaerostilbe repens* as a primary parasite of the seedling West Indian lime is still in doubt, and there is in Trinidad a so far totally unexplained root disease of the sour orange. The conditions under which the limes are grown vary from island to island, and therefore, research work of this nature cannot be entirely carried out in Trinidad. Among the problems requiring investigation are the following. Firstly, the status of *Sphaerostilbe repens* as a primary parasite of seedling limes must be established or refuted. Secondly, a detailed search for other fungus parasites of the roots of seedling limes and other citrus varieties should be made in all the islands. Thirdly, the root disease of the sour orange stocks of grapefruit in Trinidad should be studied. And fourthly, a detailed investigation of the physiology and ecology of seedling lime trees and of the different types of citrus used for stocks should be made, with a view to determining the best stock for each area. Much of this work could be done in three years by a specialist officer, with results of possibly far reaching importance to the lime industry of the British West Indies.

References.

1. Ashby, S. F.—Diseases of Limes and Sugar-Cane in the West Indies. *Kew Bull. Misc. Inform.* No. 7, pp. 209-214, 1929.
2. Baker, R. E. D.—Root Disease of the Lime in Montserrat. *Tropical Agriculture*, Vol. XIII, No. 6, pp. 147-148, 1936.
3. Briant, A. K.—Root Disease of the Lime in Montserrat. *Report (Unpublished)*, 1934.
4. Briton-Jones, H. R.—Report on a Tour to the Leeward Islands. *(Unpublished)*, August, 1927.
5. Brooks, F. T.—Some Diseases of Plantation Rubber in Malaya. *Ann. App. Biol.*, II, No. 4, p. 217, 1916.
6. Fennah, R. G.—Citrus Pest Investigations. Govt. Printer, Trinidad, Nov. 1937.
7. Harcourt, F. G.—Root Diseases in Dominica. *Report (Unpublished)*, July, 1927.
8. Nowell, W.— *Ann. Rep. Dept. Agric.* Dominica. pp. 11-15, 1914-15.
9. Small, W. and Bertus, L. S.—On the Parasitism of *Sphaerostilbe repens*. *Ann. Roy. Bot. Gdns. Peradeniya*, XI, 2, p. 189, 1929.
10. South F. W.— *Ann. Rep. Dept. Agric.* Dominica. pp. 9-14, 1912-13.
11. Stell, F.— *Ann. Rep. Dept. Agric.* Trinidad and Tobago, 1934.
12. Tunstall, A. C.—Some Observations on Violet Root Rot. *Quar. Journ. Sci. Dept., Indian Tea Assoc.*, Pt. 2, p. 69, 1927.

MICRO-ORGANISMS CAUSING FERMENTATION FLAVOURS IN BARBADOS MOLASSES.*

DURING recent years a considerable quantity of a high grade cane syrup has been shipped into the U.S.A. from Barbados, B.W.I. This "Barbados Molasses" is sold at a slightly higher price than domestic syrups and generally distributed in barrels. On arrival in the U.S.A., the molasses is stored in barrels for some months prior to distribution. During this "curing" period several reactions take place. First there is an active yeast fermentation accompanied by vigorous gassing, during which mostly alcohol is produced. A distinct odour and flavour of alcohol can be detected. After this fermentation stage, a rum-like flavour develops, which increases in intensity upon prolonged storage.

Allen,† discussing the manufacture of Jamaica rum, pointed to the importance of *Bacillus butyricus* and *Bacillus amylobacter* and allied forms in the production of organic acids which are essential in the flavouring of rum. He also described the part played by yeasts in the production of alcohol, a forerunner of the aromatic esters; during the earlier part of the fermentation of the cane juice, the *Saccharomycetes* predominated but as the acidity developed the *Schizosaccharomycetes* became prevalent; at the end of the fermentation only bacteria could be isolated from the "dead" liquor. He contended that at the end of the yeast fermentation the bacteria utilize the dead yeast cells as a source of food. *Bacillus mesentericus* was thought to produce butyl alcohol in the fermenting mixture.

Since the changes in the flavour of curing molasses suggest similar microbial activity, an examination was made of the micro-flora of several samples of Barbados molasses. A microscopical examination of sediment revealed the presence of numerous yeast and bacterial cells. Tubes of sterile malt-extract broth containing approximately 25 per cent. cane syrup were inoculated with the sediment from the molasses, incubated at 30°C. for 12 to 18 hours, and plates poured with cane syrup agar. These plates revealed the presence of a variety of yeast colonies, which were picked and transferred to slants of cane syrup agar, and later found to be the true agents of the alcoholic fermentation in the Barbados molasses.

Eleven cultures were thus obtained from two samples of Barbados molasses made in 1932 and 1933, maintained on slants of clarified honey agar and studied morphologically, culturally and physiologically. As a result of these studies the yeasts were divided into two groups: (1) *Zygosaccharomyces nussbaumeri* Lochhead and Heron and (2) *Zygosaccharomyces major* Takahashi and Yukawa.

A study was also made of the bacteria consistently appearing on solid and in liquid media. A variety of colonies developed under practically all the test conditions in agar media. No one type of organism predominated, and subsequently none could be found to play a part in the flavouring of syrups. Mould colonies (mostly *Penicillium* and *Mucor*) were frequent on plates incubated at lower temperatures under aerobic conditions. However, anaerobic organisms appeared to be most prevalent. Later these were found to play a part in the flavouring of laboratory samples of syrups. Finally *Clostridium saccharolyticum* Bergey *et al.*, was isolated. It probably aids in the flavouring of these syrups.

Also, a chemical examination was made of the volatile substances of a barrel of cured Barbados molasses. In this part of the research, the steam distillate was fractionated with a Glinsky column, and 2444 c.c. of ethyl alcohol boiling below 80°C. carrying most of the characteristic Barbados flavour were obtained. Careful fractionation gave a small amount of highly flavoured distillate in which furfural was identified by its semi-carbazone. After the removal of the furfural an aldehyde was obtained by treatment with sodium bisulphite. It had an unmistakable odour of vanillin, but chemical proof of the presence of this compound was lacking. In the non-aldehyde fraction butyl alcohol was recognised by its odour. The constituents forming the true Barbados flavour were not isolated.

These results add additional support to the belief that the flavouring of Barbados molasses is the result of a fermentation similar to that occurring in the manufacture of rum. The chief organism concerned is necessarily a yeast, upon which reliance must be placed for the production of alcohol. The volatile esters, higher alcohols, furfural and aldehydes probably result from the metabolism of bacteria.

Further evidence to support the theory of rum fermentation in Barbados molasses has been obtained by the development of fermentation flavours in domestic cane syrups. Cultures of the yeast and bacteria previously described have been propagated in sample of high-grade cane syrups and have resulted in the production of flavours not unlike those of Barbados molasses.—(*Int. Sugar Jr.*, Vol. XXXIX, No. 468. pp. 478-79, 1937.)

Dr. C. W. Wardlaw's series of articles on the Storage and Transport of tropical fruits and vegetables which was published in Vol. XIV, Nos. 3-12, 1937 of *Tropical Agriculture* is now published in the form of a reprint [price 4*s.* 0*d.* (British) and 4*s.* 6*d.* (foreign) post free] which may be obtained from the Editor, *Tropical Agriculture*, Imperial College of Tropical Agriculture, Trinidad, B.W.I.

---

* By H. H. Hall, L. H. James and E. K. Nelson of The Food Research Div., Bureau of Chemistry and Soils, U.S. Department of Agriculture.

† *West Indian Bull.*, 1906, 7, p. 141.

SWOLLEN SHOOT OF CACAO.*

In June, 1937, at the request of the Secretary of State for the Colonies, Mr. H. A. Dade visited the Gold Coast to examine the 'new disease of cacao known as Swollen Shoot and Die-back'. His objects were firstly, to determine the extent of the danger to the cacao industry in the Gold Coast; secondly, to determine the cause of the affection; and thirdly, to make recommendations for its control.

The swollen shoot symptoms consisted of swellings in chupons, fan branch twigs, and roots of cacao, and were due to an excessive radial growth of the woody tissues—which were, however, not abnormal in detail—coupled with inhibition of axial growth. They sometimes occurred in roots of trees showing no shoot swellings, and were found more commonly on chupons than on fan branches. In general, they occurred only rarely on standing trees in the die-back patches, and then more usually on individuals in the last stages of die-back. They were freely produced on water-shoots springing from the collars of affected trees which had been pollarded.

No parasitic organism was found in association with the swellings, nor were the symptoms consistent with those of diseases caused by fungi, bacteria or nematodes. In addition, the Entomologist, Mr. G. S. Cotterell, was of the opinion that swollen shoot was not the result of insect attack.

The production of dwarfed pods sometimes attributed to the swollen shoot 'disease' probably cannot be accepted as a symptom of the affection as such pods were commonly produced in very dry seasons. Leaves borne on affected trees sometimes exhibited chlorosis and some degree of puckering between the veins, but this symptom again did not occur consistently. The affection appeared to be systemic, since the swellings occurred on roots as well as on shoots. The possibility of a virus disease could not at present be excluded, although this explanation was thought to be unlikely. A more probable explanation of the swollen shoot phenomena was that they indicated a physiological disturbance due to extremely unfavourable environmental conditions, such as a deficiency of some element of which a mere trace was essential to normal growth. The nature of the symptoms, the fact that young seedlings, and young trees in young orchards were not affected, while occasionally young saplings in old orchards have been, was not inconsistent with a hypothesis of a soil deficiency disease. This was considered to be the most promising line of research.

Following the swellings, the shoots died back, though death of the entire shoot was deferred, some making further and repeated axial growth from lateral buds near the apex of the still living wood, and showing a series of swellings. This alternate death of the growing point and its replacement by side shoots, was, however, the normal process of partial recovery, in response to temporary improvement in the water-supply, in trees affected by drought die-back, which occurred in a severe form all over the swollen shoot area. The dying back of swollen shoots could not therefore be attributed with certainty to the same cause as that of the swellings, since all the affected trees were suffering from drought die-back. There was no evidence of swollen shoot phenomena in even reasonably healthy and well-protected cacao, *i.e.*, in trees which had not been affected by drought die-back. The conclusion was reached, therefore, that swollen shoot was a secondary affection which appeared only in trees depressed by the conditions, extremely unsuitable for cacao and always associated with drought die-back, which now existed in the area under consideration, and that the real problem was that of drought die-back.

Drought die-back was well known in all cacao-producing countries, and was also known as 'physiological die-back' and 'Diplodia die-back'. In the Gold Coast critically dangerous climatic conditions prevailed during the dry season, lasting for some months, and in the great majority of the cacao fields the crop needed very effective protection by shade and windbreaks even where the soil was particularly good. In such soil, and in the zones of higher rainfall, the trees might have survived for a long time without shade, but they were much depressed during the dry season, when drought die-back caused a great wastage of their resources. Significant examples of the value of shade in the swollen shoot area were to be seen. Occasionally a big mango tree was found in the middle of a large area of dead and dying cacao, and in its dense shade were clustered three or four cacao trees in good, or even excellent condition, in striking contrast with their neighbours. In all the cacao districts, the crop was originally established in good forest conditions. Farmers had usually left shade trees in their farm clearings and protective bush round them. The original shade trees had now largely disappeared, while much of the surrounding bush had gone. The consequent increase in desiccation had not only affected cacao—it had also prevented growth of the more suitable forest-complexes. A great many, if not all, of the older cacao areas throughout the country were thus affected to a greater or less extent. The district at present under consideration was an extreme case, but serious trouble was confidently expected elsewhere in the course of time.

Scattered around and within a few miles of Nankese there were numerous farms in which the trees were all, or nearly all, dead. The size of the dead trees and the development of their branch systems and cushions showed that they had been once in splendid condition and had given excellent crops. Now the dead cacao stood

* Abstracted from Mr. H. A. Dade's Report on his visit to the Gold Coast. Government Printing Department, Accra, Gold Coast, 1937; price 1s.

without cover and in expanses of thick grass. The history of this cacao was well known. Exposure and drought die-back had been well advanced some years ago. In 1933 there had definitely been no swollen shoot there, and while it could now be found here and there in some of the few surviving trees, all the evidence afforded by older growth indicated clearly that it had appeared very recently—apparently within the last two years; that is, long after the greatest part of the damage had been done. It was significant that, even in this extreme case, on the borders of open, grass-covered patches, occasional cacao trees could be found still alive and in fair condition, in the shelter given by one or two surviving 'bush' trees of suitable habit.

Control measures now in operation consisted of the cutting out and destruction of dead trees and others suspected of affection by swollen shoot. These measures had been based on the early assumption that swollen shoot symptoms were confined to a relatively small area. It had afterwards been found, however, that a very large area was affected, over which complete extirpation was virtually an impossible task. Experience had shown that the treatment was not efficacious, and moreover, it was not practicable owing to the relatively small number of trees in which the symptoms were found, and to its confusion with drought die-back. The wholesale clearing out of trees, especially during the dry season, had increased exposure and accentuated drought die-back, the real cause of the trouble. It was recommended that the present operations be discontinued, as being inefficacious and actually harmful.

The assumption that cacao cultivation could not be continued in this area and should be abandoned was, in Mr. Dade's opinion, unjustified. He considered that it was not too late to save a great deal of the standing cacao, and even, in time, to reclaim the lost ground. A policy of regeneration should be adopted, which should commence with the immediate institution of a programme of intensive replanting of shade trees and windbreaks. This should be extended to all cacao fields, and in time, should assume the status of maintenance work. It should include the re-establishment of young cacao, which in the past had often been difficult or impossible owing to destructive insects, but was now more hopeful in the light of increased knowledge.

In conclusion Mr. Dade re-iterated his warning made eleven years ago regarding the urgent need of maintaining the environmental conditions necessary for the preservation of this crop, on which the prosperity of the country mainly depended. The swollen shoot area was by no means the only one in which the older farms were suffering severely from deterioration—every district was affected.

Appendices on the swollen shoot research programme, the Drought Die-back Problem, the Age Limit in Cacao, and the Reconstruction of Protection are given at the end of the report.

R. E. D. B.

SOIL-LESS HORTICULTURE

"Hydroponics" is a system of soil-less horticulture developed at the University of California by which enormous yields of flowers and vegetables may be obtained from plants feeding on chemical solutions.

One of the first persons to take it up has been Mr. Ernest W. Brundin who has started an indoor market garden at Montebello, California, and is feeding a compound of salts according to secret formulae discovered by Dr. F. W. Gericke, associate plant physiologist at the University's Agricultural Experimental Station. Brundin grows 8,000 tomato plants in sawdust and water on a third-of-an-acre plot under glass. These tomatoes, along with a few cucumbers, grow in 120 tanks, through which 60,000 gallons of water circulate constantly. On cloudy days, Brundin adds 8 lb. of salts, increasing the feeding on sunny days to 15 lb.

Feeding of minerals in solution, according to Brundin, assures the presence in the fruit of all beneficial elements. This is considered to be one of the most important features of controlled feeding in agricultural production. So successfully have Dr. Gericke's salts formulae, containing 16 weighed and some 32 uncontrolled elements, and Brundin's patented circulation system worked together, that the indoor market garden produces on vertical vines tomatoes at the rate of 120 tons annually per acre, or some ten times the production from horizontal vines in the field. In addition, the last crop brought an average price of 13.1 cents a pound, or approximately £6,290 an acre.

Instead of transplanting according to the customary field practice, Brundin plants the seeds in a 2-inch layer of sawdust placed upon wire netting. The seeds are covered with rice hulls, which restrict evaporation. Water in the tanks is brought in contact with the seed bed, which keeps the seed moist, and assists in speedy germination. As roots extend downward, the water level is dropped.

Temperature within the tanks is maintained at 80 degrees; tobacco is not permitted either indoors or out, since a tobacco virus may attack the plants, and the rooms are fumigated at intervals to halt incipient disease. Since food reaches the plants from only two sources, the air and water, the operator of this novel farm need only analyse the water at intervals, weigh out the salt ration, and keep the air clean, to know precisely the elements being "eaten" by the roots and leaves. The vines reach an average height of 15 feet, and produce from November until August before being pulled from the boxes.—(H. J. S. in *The Sphere*, Vol. CLI, No. 1971, p. 192, 1937.)

AN EXPERIMENT ON THE HAND-COLLECTION OF EGG-MASSES OF CITRUS WEEVILS (*DIAPREPES* SPP.) IN ST. LUCIA.

By G. B. Gregory, Dip. Agric. (I.C.T.A.).
(*Acting Agricultural Superintendent, St. Lucia.*)

The practice of hand-collecting for the control of the more obvious forms of insect pests has, for many years, enjoyed a considerable measure of popularity, and has been recommended and employed with confidence by numerous workers concerned both with the scientific and the practical aspects of agriculture. Of late, however, the effectiveness of the practice has been brought into question, and this has provided material for a critical paper recently published by Le Pelley (1) in which he describes an experiment designed to test the efficiency of hand-collecting as applied to a species of *Antestia* on coffee in Kenya.

The results of Le Pelley's work show that hand-collecting, when applied to *Antestia*, proves to be useless as an economical means of control. The cost is out of all proportion to the percentage of insects obtained, and he suggests that, in one case under report, hand-collection may even have been responsible for the continuance of severe attack. He suggests also that similar experimental results might be obtained in other accepted programmes of hand-collecting as the following investigation will show.

The experiments described in this paper were designed, on the suggestion of Mr. R. G. Fennah, Entomologist, Citrus Pest Investigation, Leeward and Windward Islands, to test the possibility of controlling the Citrus Weevils (*Diaprepes* spp.) by hand-picking of egg-masses on lime trees in St. Lucia, British West Indies. The eggs of these weevils are laid, typically, between a pair of leaves cemented together, in which position the egg-masses are easily detected. The collection of adult beetles and of their eggs has already been considered as a means of control by Hutson (2), Wolcott (3) and Fennah (4).

The co-operation of the owner and management of the estate on which the first set of experiments was done is gratefully acknowledged; the writer also wishes to record his grateful appreciation of the helpful interest shown by Mr. R. G. Fennah, Entomologist, Citrus Pest Investigation, and Mr. E. A. Walters, Agricultural Superintendent, St. Lucia.

The Possible Application of Hand-Collection of *Diaprepes*.

The hand-collection of adult beetles or hand-picking of egg-masses presents many difficulties. At first glance, the conditions seem almost ideal for the successful use of the method because of the size of the adult weevils, the ease with which they may be seen, and the large numbers in which they congregate on the trees. Their habit of taking flight when disturbed and the diversity of their host plants, however, seriously militate against effective control by hand-collection. To quote Wolcott (3), who recommends a cloth spread under the tree to catch the beetles: "The boys must be spry indeed to capture them before they fly away or scramble out of sight".

With regard to the egg-masses, the position seems somewhat better, for even though eggs are laid on the leaves of alternative hosts, the larvae, as far as is known, are initially confined to the soil around the tree on which the eggs were laid. It should follow, therefore, that a tree that is kept free of egg-masses, or from which the egg-masses are removed before hatching, is safe from larval attack. If then, egg-masses are picked from the citrus trees and from the *Gliricidia* trees, which are extensively used for shade, hedges, wind-breaks, &c., throughout the cultivation, it should be possible to ward off larval attack. This point has been considered by more than one planter and on one estate attempts were made to encourage the picking of egg-masses, the labour to be paid according to the number collected; little enthusiasm was shown by the labourers and the idea was abandoned.

Experimental Work.

The field work in connection with the experiment consisted of five different sets of hand-pickings, spread over a total of 150 trees as shown in Table I.

Table I.

Number of trees.	Time of	
	First picking.	Subsequent picking.
40	10 minutes	Until no further egg-masses could be found.
35	15 ,,	
30	20 ,,	
25	25 ,,	
20	30 ,,	

The method was the same for each set of pickings. The required number of trees was chosen and each tree marked with a numbered stake; four women were used for the timed pickings, two being allotted to each tree. Two trees were thus dealt with at a time. Each pair of pickers was provided with a numbered paper bag into which the collected egg-masses were placed.

As soon as the first pair of trees had been picked over for the first time, three women were put to each with instructions to search until they felt sure that they had removed all the remaining egg-masses, numbered paper bags again being provided.

No strict note was taken of the time required to complete the second picking of each tree. If, however, after about half an hour's searching,

a further ten minutes did not yield any egg-masses, the tree was regarded as clean and the searchers moved on to the next; a "find" in that ten minutes, however, resulted in the giving of another ten minutes, and so on, as long as any egg-masses were found.

All operations in the field, throughout the experiments, were under the close supervision of the writer. The counting of the egg-masses was done by him personally.

Results.

Table II shows the results obtained from the different sets of hand-pickings carried out.

Table II.

	Number of trees and time of first picking in minutes.				
	40 at 10	35 at 15	30 at 20	25 at 25	20 at 30
No. of egg-masses in first picking	859	325	266	254	141
No. of egg-masses in second picking	694	164	112	84	38
Total ...	1,553	489	378	338	179
Percentage in first picking ...	55.31	66.46	70.37	75.15	78.78
Standard Error	2.211	4.005	2.641	2.455	3.021

These results are expressed graphically in Figure 1, the time in minutes taken by two women being plotted against the percentage of egg-masses hand-picked in that time. The Standard Error of each point is represented by the vertical line running through the point, the positive error on one side above the point and the equal negative error on the other.

Examination of the graph shows how the rate of increase in the percentage of egg-masses obtained decreases as the collection time increases. For example, an increase in time allowance of five minutes, from ten minutes to 15 minutes, gave an increase in percentage of 11.15; a similar five-minute increase, but this time from 25 minutes to 30 minutes, gave an increase in percentage of only 3.63.

The trees used for the experiment were West Indian limes budded on sour orange stock, about 4½ years old, and of an average height of seven to eight feet. One set of pickings was done on a private estate, the remaining sets at the Union Agricultural Station. In all but the first set the women were provided with hooked sticks with which to pull down the top branches and so enable them to search through all the foliage. In the first set, no sticks were used, so that the amount of foliage searched was limited to the amount within reach of the pickers. As there was very little variation in the heights of the women, it can safely be assumed that, for each tree, the same area was picked over in each of the two pickings.

The labour employed was of the usual estate class of worker, and though not at first familiar with the work was found to be readily adaptable. In order to obtain some idea of the efficiency of these workers, and to establish as it were, some sort of control figure, a separate set of pickings was done on ten trees by the agricultural cadets at the Union Station. The time allowed for the first picking of each tree was 15 minutes, with the second picking as already described. These boys may be considered familiar with the work, inasmuch as for several months it has been part of their duties to hand-pick a block of trees, forming part of another experiment, at intervals of four days. The control figure for 15 minutes so established compares favourable with that previously obtained, being 68.93 per cent., as against 66.46 per cent., and well within the Standard Error of the first point. This extra point is shown on Figure 1 in a square.

Mention should here be made of the impracticability in this problem of using small children for hand-collecting; even if they are provided with hooked sticks, the height of any but very young trees makes it impossible for all the foliage to be examined. In general, also, the spiny habit of the lime makes the task an unpleasant one; thorough supervision is also essential if the work is to be done with a minimum of idling on the part of the labourers.

Costs.

The main factor influencing the adoption or rejection of any suggested method is that of cost.

At 15 minutes per tree, and in an eight-hour day, two women would, under ideal conditions, hand-pick 32 trees at a cost of 1*s.* 8*d.* (two women

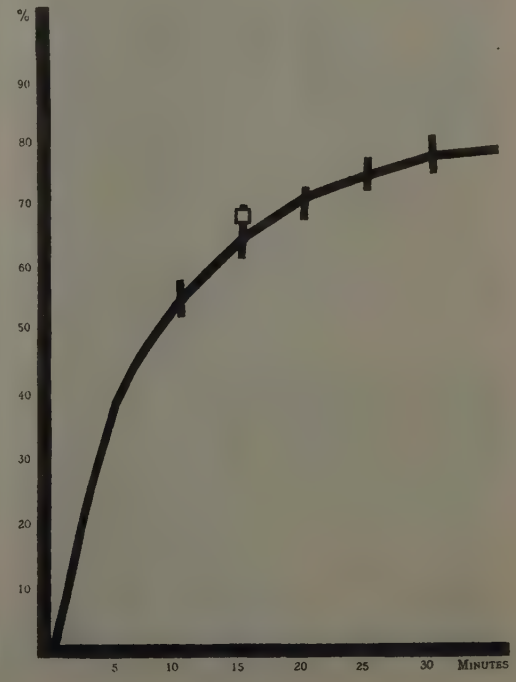


Fig. 1.

at 10*d.**) ; this is equal to a cost of five-eights of a penny per tree. In order to collect the egg-masses before hatching, picking would have to be done about every five days, starting in March and continuing up to August ; with a *minimum* of 100 trees to the acre, it would therefore cost over £1 10*s.* 0*d.* per acre per month. Under these conditions, only about 67 per cent. of the egg-masses would be collected, leaving more than 30 per cent. to hatch and fall to the ground. With this large percentage left over from every picking the trees would still suffer to an economically serious extent, and the time and money spent on hand-picking would be wasted.

The experiments show that an average of 60 minutes per tree would be necessary to remove all egg-masses. The cost of this labour, performed every fifth day during the oviposition period, would be about £12 10*s.* 0*d.* per acre per month.

It is obvious that control of *Diaprepes* by hand-picking of egg-masses is entirely impracticable on trees of seven to eight feet or more in height. In young nurseries, however, this method might be applicable.

* 1936 wage rate.

Summary.

An experiment on hand-picking of egg-masses of Citrus Weevils (*Diaprepes* spp.) on lime trees, seven to eight feet high in St. Lucia is described. The time and cost incurred were so great that the method is regarded as entirely impracticable, though it is suggested that it might be effective on very young nursery stock.

References.

1. Le Pelley, R. H.—*Bull. Ent. Res.*, 26, page 533.
2. Hutson, J. C.—Report on the Agricultural Department, St. Lucia, 1917-18.
3. Wolcott, G. N.—An Economic Entomology of the West Indies. *Puerto Rico*, 1933.
4. Fennah, R. G.—Citrus Pest Investigation. Oviposition and Parasitism of *Diaprepes* in St. Lucia in 1937, including Notes on Citrus growing Areas and on Recent Experimental Work. Govt. Printer, Trinidad.

A FIELD TRIAL OF THREE POPULAR GREEN MANURE CROPS IN TRINIDAD.

By P. J. Sauvage.

The value of green manuring in the maintenance of soil fertility is widely recognised in Trinidad. The introduction of a green manure crop in the rotation is a practice adopted on many sugar estates and to a less extent among local farmers. The essentials of a good green manure crop are well known. Briefly, they are rapid germination and growth, so as to ensure a quick and heavy yield of green matter, and produce an effective weed smother. The crop is ploughed under in the green condition, usually when the first signs of flowering appear. At this stage, the plants should not be too woody or fibrous in character, as this would make the ploughing more laborious and slow down the ultimate decomposition in the soil. A leguminous crop is generally preferred, because it can fix atmospheric nitrogen by means of its root nodules.

Three of the most popular green manure crops in Trinidad are :—Sunnhemp (*Crotalaria juncea* Dill. ex L.), Woolly Pyrol (*Phaseolus mungo* L.), and Sword Bean (*Canavalia ensiformis* D.C.). An accurate comparison of the relative merits of these crops should be of some local interest. With this object in view, a replicated experiment was laid down by the third year diploma students in Field I of the College farm in November 1937. The soil type is an acidic loam of rather low nutrient status. The experiment was planned on the randomised block principle, with six blocks and six treatments, comprising the three green manure crops each at two rates of nitrogenous manuring, namely, 0 and 1½ cwts. of sulphate of ammonia per acre. In order to eliminate possible edge interference, a non-experimental border was established round each plot. The effective plot size was 1/36th acre. All the plots were sown by hand on the 11th November, 1937. The Sunnhemp and Woolly Pyrol were both broadcast at the rate of 40 lb. per acre, but the Canavalia was sown in shallow drills two feet apart at 100 lb. per acre. The manure was applied when the seed was sown, and the soil was then lightly harrowed and left without further cultivation.

Careful notes were kept of the progress of the different varieties up to the time of harvest. The germination of the Sunnhemp was both good and quick, being practically over in three days. By then both the Canavalia and the Woolly Pyrol had only started germinating, the process continuing for another ten days. With the Woolly Pyrol, the final stand was both patchy and thin. This can, in part, be attributed to a very heavy shower of rain 2.19 inches in all, which fell the day after sowing. This rain caused considerable surface washing of the soil with marked effect on the germination of the broadcast plots, particularly on those sown with Woolly Pyrol. The Sunnhemp very soon recovered from this flooding, and grew so quickly that it effectively smothered any weeds which had sprouted. The Canavalia, being slower in early development allowed a certain amount of weed growth at first but successfully outgrew these weeds later on. In the Woolly Pyrol, the weeds grew quite as quickly as the crop, and this, combined with the initial irregularity in germination, produced a thoroughly weedy stand at harvest. All plots were cut and weighed on 10th January, 1938, two months after sowing. By that date, the Sunnhemp had attained a height of six feet and together with the Woolly Pyrol had flowered freely and begun to show signs of setting seed. The Canavalia plants, on the other hand, were still in a vegetative stage of development.

YIELD DATA IN LB. OF GREEN MATTER PER 1/36 ACRE PLOT.

Varieties.	Block I	Block II	Block III	Block IV	Block V	Block VI	Treatment Totals.
Canavalia no manure	145	194	173	154	195	285	1,146
Canavalia manured	209	194	226	305	184	292	1,410
Woolly Pyrol no manure	57	91	119	186	170	107	730
Woolly Pyrol manured	126	156	83	184	157	75	781
Sunnhemp no manure....	229	278	246	331	323	288	1,695
Sunnhemp manured	306	287	306	282	412	305	1,898
Block Totals	1 072	1,200	1,153	1,442	1,441	1,352	7,660

Analysis of Variance Table.

Due to	S.S.	D.F.	Variance.
Total ...	257092	35	—
Blocks ...	20512	5	4102
Variety ...	180614	2	90307
Manure ...	7453	1	7453
Interaction ...	2006	2	1003
Error ...	46506	25	1860

Application of the Z test shows a significant result for variety at the five per cent. point. At this level, the manurial effect just fails to be significant; the interaction factor is obviously non-significant.

The yield for the three varieties is as follows:—

	Tons per acre.
Sunnhemp	5.4 ± .20
Canavalia	3.8 ± ,,
Woolly Pyrol...	2.3 ± ,,

It is obvious therefore, that for yield of green matter Sunnhemp is decidedly the best, and Woolly Pyrol the worst. For a short season crop, Sunnhemp has much to recommend it. It rapidly produces a thick cover which smothers weeds, and provides a large bulk of green matter of good quality for incorporation in the soil. Its chief drawback is the difficulty of obtaining adequate supply of seed, as at certain times of the year the *Utethesia* moth may practically preclude the setting of seeds. The plant also suffers from a *Fusarium* wilt and there is evidently scope for improvement by the importation of one of the available wilt immune types. The *Fusarium* attack rarely becomes serious before the plants mature and is therefore a drawback mainly when seed production is aimed at.

Canavalia also has many good points. Over a longer period, the yield of green matter should at least be as good as that from Sunnhemp, and, for a crop lasting three to four months, Canavalia would be the better species to use. Being at first rather slow in development, a certain amount of weed growth must be expected; but as the crop is best sown in close rows, a single intercultivation in fields, where the weed population has become excessive, should effectively control any such infestation. A good crop of Canavalia forms an excellent cover but the green produce is perhaps a little more woody than that of Sunnhemp. In certain seasons, in Trinidad, the plants are liable to be badly attacked by *Diabrotica* beetles, especially from June to September, otherwise this crop is particularly hardy and vigorous. The root development must also be taken into account in evaluating a green manure crop, and of the three varieties Canavalia has the deepest and best developed root system, adding considerably to the recorded weight of organic matter returned to the soil.

Woolly Pyrol was a failure in this experiment, the yield of green produce was not only small but also of low value consisting mostly of weeds. It suffers too, from depredations of *Diabrotica* beetles to a greater extent than Canavalia. It is possibly more suited to fertile soils free from serious weed infestation.

The manurial effect was not obvious. This is probably due to the heavy rainfall shortly after application, which must have leached out much of the fertiliser or even washed it on to the unmanured plots. There is an indication that the yields have gone up, and it is possible that a light nitrogenous dressing might be useful in hastening early growth. Further experimentation is required to ascertain this.

In conclusion the writer wishes to acknowledge his deep indebtedness to his colleagues Messrs. Stuart, Ray, Gonzales and Churaman who equally with himself were responsible for the planning and carrying out of this field trial.

REVIEWS.

PHYTOHORMONES.

By F. W. Went and K. V. Thimann, *The Macmillan Co.*, New York, 1937, pp. 294, price 17*s*.

Less than 20 years ago a theory was put forward that the growth of oat seedlings was controlled by a substance produced in the growing tip which, on moving downwards out of the tip, regulated growth in the seedling. To-day this theory is an established fact, and applies not only to oats but to all plants. The substance causing growth has been identified and a more plentiful source has been found in urine. Substances with similar action have been isolated from other natural sources, such as malt, and the establishment of the chemical identity of these naturally occurring auxins, as they are known, has led to the synthesis of closely related compounds, some of which have been found to possess growth regulating activity in varying degree. All these plant growth regulating substances are classified together as phytohormones.

The book under review deals with the hormones of higher plants. The introductory section consists of a short historical introduction to the subject, showing how apparently unrelated observations have jointly led to the present conception of hormones. This is followed by a very useful section on methods for the biological assay of these substances, with sufficient detail for their experimental application. Subsequent chapters are devoted to the formation and occurrence of auxin in plants, its movement about the plant, and the manner in which it regulates growth.

The latter half of the book is devoted to the discussion of the different effects of auxin on plant growth and this section should be of considerable interest to agriculturists. One effect which is already widely known is that on root growth, which is stimulated by auxin. Attempts to make use of this information in the propagation of cuttings by first treating them with auxin solution have not had the success at first anticipated, for, while the rooting of cuttings which normally strike without much difficulty can be accelerated by such treatment, the rooting of cuttings which are normally difficult to strike is not accelerated to the same extent by such treatment. In these cases the difficulty would appear to be in attaining and maintaining a satisfactory auxin content in the cutting. Very recent information suggests that Vitamin B may be a factor in root growth, for its presence considerably accelerates the action of auxin. There would appear to be considerable hope that difficulties in striking any type of cuttings may be overcome by further investigation along these lines. Chapter XI, on Root Formation can be especially recommended to all interested in the vegetative propagation of plants.

The many activities of auxin, most of which are as yet very imperfectly understood, show how important a factor it is in plant growth and development. The practical application of these new conceptions, and their influence on agriculture must for the present, apart from such isolated instances as the use of auxin in striking cuttings, remain matters of conjecture, but the closer understanding of the plants' behaviour made possible by them cannot fail to exert a profound influence on the future development of plant sciences.

The subject is one in which rapid development is still in progress, and the book would appear to be primarily a progress report for the specialist, analysing and integrating as many as possible of the present known facts. This excellent objective is worthily attained, and the usefulness to the specialist is further enhanced by the inclusion of practical methods for auxin assay. The general reader should find much of interest in the book, particularly the historical introduction and the section dealing with the effects of auxin on plant growth.

E. P.

* * *

GROUND WATER.

By C. F. Tolman, *McGraw-Hill Pub. Co., Ltd.* London, 1937. pp. 593, price 36*s*.

This is a textbook of hydrology by the Professor of Economic Geology at the Leland Stanford Junior University, California, U.S.A. In it an attempt is made to co-ordinate scientific data regarding the occurrence, movement and activities of the subsurface water of the earth's crust, and the properties of water-bearing materials. Intensive investigations of ground water began only some forty years ago, and since then the subject has grown almost to a new science. Much of the information has been obtained by studies in the semi-arid western United States. The development and utilisation of supplies of ground water range from the simple water-well to extensive municipal and national schemes of water conservation, involving the services of geologists and engineers. The book is divided into seventeen chapters, and includes a glossary of terms, tables of hydraulic conversion factors, and a 25-page index. Lists of references are appended to each chapter or are presented as footnotes, and the text is illustrated by 189 figures, including diagrams, maps and photographs. The discussion of principles comprises a well-balanced mixture of theory and practice, and even the legal aspects of water utilisation are given due prominence.

The importance of meteorology in hydraulic investigations is fully discussed in one chapter, wherein the contributions to available soil water by rain, run-off water, surface evaporation and plant transpiration are duly considered. Another chapter is wholly confined to the elements of pedology, while others concern soil permeability, water tables, seepage, soil aeration, and water storage beneath impervious strata. The main

features of water wells and water springs are described in two special chapters, and the movements of liquids, both water and oils, within oil-fields are considered in another section. The last chapter is devoted to a detailed description of the ground-water provinces of the United States and the Hawaiian Islands.

Professor Tolman's pioneering treatise on ground water can be strongly recommended to geologists, engineers, soil investigators and students of agriculture, as an interestingly written and well documented account of a very important subject. The appalling wastes of water reserves, the privations caused by drought, and the ever-present menace of soil erosion by floods, sufficiently indicate the need for detailed studies of hydrology, and the author of this book deserves the thanks of those in authority in government administrations, public works departments and geological and soil research institutes for so ably co-ordinating the known facts of the subject in a form that attracts immediate attention.

F. H.

* * *

THE EVOLUTION OF SUGAR-CANE CULTIVATION IN MAURITIUS.

By A. North Coombes, B.Sc., Dip. Agric., pp. 197, map and illustrations.

The author has set himself out to trace the changes which have taken place in the cultivation and manufacture of the sugar-cane crop in Mauritius, from the earliest arrival of planting material in 1650, when the island was under Dutch occupation, up to the present day.

The result is a book which cannot fail to be of interest to cane growers and manufacturers in other parts of the world, for there is much to learn from the difficulties the industry has encountered and the way in which it has surmounted them. As the Director of Agriculture writes in his preface: "A perusal of all that is set forth within this volume gives one to understand quite clearly why that fine body of men—the Mauritian planters—have every reason to be proud of the undoubtedly high standard of their cultivation."

Among so much it is difficult to select, but nothing surely can emphasise the difference between conditions in Mauritius and in Trinidad, than the history of mechanical tillage. In Trinidad, the tendency is everyday to use more and larger tractors, but in Mauritius, the reverse is the case, and though in 1926 there were as many as 116 tractors at work, very few are being used to-day and hand-cultivation has been almost entirely restored.

Again, for dramatic effect, the history of the introduction of *Diatraea*, the cane borer is remarkable, for it appears that the consignment of canes in which it came in 1848 from Ceylon was known to be infected, and it was the intention to destroy it on arrival. Unfortunately, a few canes were stolen outside the Port Office, and by 1856 the insect was reported all over the island. The damage caused was considered so serious, that the Government offered a reward of £2,000 to any person who should suggest an efficient practical means of control. Our author does not say whether this was even awarded: presumably, it was not.

R. C. W.

* * *

EARTH LORE.

By S. J. Shand, *Thomas Murby & Co.*, London, 2nd Edition, 1937, pp. 144, price 3*s.* 6*d.*

This fascinating little book, whose sub-title is "Geology without Jargon", should be read by everyone who is the least attracted by the earth's internal mysteries and its past history. Once started, its 144 pages will be consumed with increasing and almost breathless interest. As an introduction to geology, it could not be surpassed. Among the topics discussed in it are the "creation saga", the age of the earth, the composition of the earth's interior and its crust, the problem of the mountains, rift valleys, Wegener's theory of continental drift, "lost continents", the testimony of the fossil contents of sedimentary rocks, the nature of the sea-floor, changing levels of land and sea, earthquake waves, volcanic activity and the structure of the Alps, to select only a few of the many features that are presented therein. The text is illustrated by numerous diagrams and pictures; the writing is vivid and exciting, yet the statements are authoritative and never exaggerated. Once read, the beginner will certainly want to know more about geology.

F. H.

* * *

CULTIVATION BY ANIMAL DRAUGHT.

Catalogue No. 12940E, published by Ransomes, Sims & Jefferies Ltd.

The latest catalogue sent out by the old-established firm of Ransomes, Sims & Jefferies Ltd., entitled "Cultivation by Animal Draught", gives a good idea of the very wide range of implements which the firm manufactures, for it will be remembered that they sell an equally wide range of implements for use with tractors. The catalogue is attractively produced and very well illustrated. The implements are clearly depicted, and in most cases full information is given as to their weight and draught. While the latter will, of course, vary widely according to the circumstances in which the implement is used, it is equally true that the tractive force possessed by an ox is just as variable, and it would be an advantage to have the average draught expressed alternatively in lb.

For some years past, the firm have kindly supplied a full range of their catalogues for issue to College students.

R. C. W.

SUGAR NOTES.

Compiled by the College Department of Sugar Technology.

Two New Cane Seedlings.

In Bulletin No. 14 of the B.W.I. Sugar-Cane Breeding Station a detailed botanical and agricultural description is given by A. E. S. McIntosh of two new Barbados cane seedlings, B 726 and B 2935, that are thought to be worthy of serious consideration. B 726 is better adapted to regions of high and medium rainfall than BH 10 (12), but does not do as well in low rainfall areas. It is less resistant than BH 10 (12) to mosaic disease, has appreciable resistance to gumming and red rot, and does not appear to be susceptible to root rot diseases.

Relatively speaking, it is not susceptible to attack by the small moth borer (*Diatraea saccharalis*). It is regarded as an excellent factory seedling, ripens early, and maintains a very high purity and sucrose percentage throughout the crop season.

B 2935 is also a high yielding early seedling in the lower rainfall areas, but does not ratoon well if there is a lack of moisture. As a factory cane it is low in fibre and is apt to be low in sucrose in the early crop season.—(*Int. Sugar Jr.* Vol. XL, No. 471, p. 112, 1938.)

* * *

Clarification of P.O.J. Cane Juices (Cold *vs.* Hot Liming).—*J. C. B. Davidson.*

Very satisfactory milling results are obtained when crushing P.O.J. 2714, 2878, 2725, &c., and the bagasse forms an excellent fuel, but in Queensland as elsewhere difficulty is experienced in the clarification of the juices. Sulphitation had been tried out, but opinion was against its adoption until simpler methods of treatment have been given a thorough trial. Experience gained in 1935 indicated that ample settling capacity would overcome all trouble, but later it was found that this would not be so for all P.O.J. juices. In some cases with normal lime-and-heat treatment there is practically no precipitation of impurities at all. On the other hand, in others, a large settling capacity is without doubt an important factor.

Hot liming was therefore tried out in the laboratory, the following procedure being used: 50 ml. portions of the raw juice (in 6 in. × 1 in. test-tubes) were heated in a saturated brine bath to boiling point in less than 2 min. and maintained at that temperature for a further ½ min. Then they were treated with 10°Brix milk-of-lime, and transferred to a boiling water-bath so as to observe the nature of separation and the rate of settling. At the same time parallel tests were made with cold liming in the usual way.

Both treatments, however, produced a very unsatisfactory clarified juice, especially in the case of the cold treatment, being in fact little better than raw juice in respect of colour and turbidity. Addition of phosphoric acid, however, made all the difference. It was then found that hot liming and high P_2O_5 combined gave a very promising clarified juice.

Further observation showed that with P.O.J. juices having a P_2O_5 content of 250 to 340 parts per million, hot liming produced a precipitate of granular nature, that is, having coarse flocs, which settled rapidly, leaving a lighter and brilliantly clarified juice. On the other hand, cold liming produced a finely divided precipitate of very light particles which settled very slowly with a scum which remained on top of the liquid. But with juices deficient in P_2O_5, *i.e.* less than 150 p.p.m., or thereabouts, hot liming was not much better than cold.

Factory trials with hot liming were therefore made at Bingera, and the juice heating and liming systems were modified accordingly. Brilliantly clarified juice was obtained in runs of from 6 to 16 hours, after which, on account of the large volume of mud in the subsiders, causing the juice to run dirty, the cold liming process had to be reverted to. A means of consolidating the mud in the subsiders would bring about an increased efficiency in those units. This is a matter under investigation.

Lastly, it was decided to give Davies' fractional-liming-and-double-heating-process*, and so a trial was arranged at Bingera on the full factory scale. Mixed juice was limed to 6.0-6.4 pH, heated to 205-215° F., limed to 8.0-8.4 pH, and re-heated after this to 220° F. Preliminary trials with this system gave brilliantly clarified juices until the high level in the subsiders made it apparent that this mud difficulty had here also to be solved. When the rate of mud withdrawal from the subsiders was increased, and the mud level in the subsiders was lowered, the system worked very satisfactorily.—(*Int. Sugar Jr.*, Vol. XL, No. 471, pp. 117-18, 1938.)

* *I.S.J.*, 1936, p. 298; 1937, p. 67.

* * *

Production of Cattle Fodder from Bagasse Screening and Molasses.—*By H. S. Chaturvedi.*

Mixings were made at the H.-B. Technological Institute, Cawnpore, of bagasse screenings (25 mesh, air-dried to about 10 per cent. of water), disintegrated groundnut cake and molasses in the proportions of 1 : 1 : 1.5, 1 : 1 : 2, 1 : 1.5 : 2, &c. These mixings were compressed into cakes 11 in. × 2½ in., weighing about 5 lbs. each, found to be capable of withstanding handling during storage and shipment, and of being easily softened by sprinkling with water. It is suggested that factories unable to sell their molasses should start the manufacture of "Bagomolas", a mixture of bagasse screenings and molasses (1 : 2), and sell it to the cane suppliers and others for use in admixture with half its weight of protein feed (as oil cake, cotton seed meal, *chuni*, &c.) as a cattle fodder.—(*Int. Sugar Jour.* Vol. XXXIX, No. 468, p. 487, 1937.)

CHEMICAL NOTES.

Compiled by the College Department of Chemistry and Soil Science.

Effect of Soil Reaction on Phosphate Availability.

In a paper published by the College of Agriculture, Warszawa, 1935, Dr. P. Strebeyko describes the results of pot experiments conducted during the years, 1927 to 1931, designed to test the effect of different soil reactions and of physiologically acidic and basic nitrogenous fertilisers on the availability of various forms of phosphatic compounds. The test plants used were field peas and oats. Each pot contained 17 lb. of soil or subsoil mixed with sand. The chief phosphatic substances examined were iron phosphate, aluminium phosphate and calcium superphosphate. The following results were obtained :—

(1) Iron and aluminium phosphates gave highest yields under *alkaline* reaction conditions, or when treated with basic-reacting nitrogenous manures, such as sodium nitrate and calcium nitrate. In all these cases, the effects were as great as those obtained with superphosphates, disodium phosphate and basic slag.

(2) Under *acidic* conditions, iron and aluminium phosphates gave much poorer yields.

(3) Basic calcium compounds increased the availability of the phosphate contained in iron and aluminium phosphates and superphosphate, only when soil reaction was initially *acidic*.

(4) Gypsum exerted no beneficial effect on the phosphate availability of any of the phosphatic manures tested.

(5) The availability of phosphate in superphosphate was decreased by addition of ferric hydroxide or aluminium hydroxide, both under slightly acidic and slightly alkaline conditions, but, under *highly alkaline* conditions, its availability was not decreased, since neither iron nor aluminium phosphates are precipitated in the soil when the reaction is strongly alkaline.

* * *

Tobacco Mosaic Protein.

Two papers recently available (*Proc. Amer. Phil. Soc.*, 77 No. 4, April 22, 1937) summarize the fundamental work on virus proteins carried out at the Rockefeller Institute for Medical Research. Dr. W. M. Stanley gives evidence to justify the conclusion that a protein of unusually high molecular weight, obtained by him in crystalline form, is actually tobacco mosaic virus. The crystalline protein prepared from such different hosts as tomato and phlox, has the same chemical composition, isoelectric point, optical rotation and biological activity. Normal plant protein has a much lower molecular weight, and has other properties different from the virus protein. Crystals of the prepared material are needle-shaped, 0.02-0.03 mm. long, and give a regular crystalline pattern on X-ray analysis. Dr. Stanley's paper is highly informative, and supplies a succinct digest of the most recent work on this complex subject. Dr. Ralph W. G. Wyckoff describes " The Ultracentrifugal Study of Virus Proteins " in the same journal (pp. 455-462). He gives particulars of an air ultracentrifuge inspired by the original apparatus of Svedberg, with which he has demonstrated that the virus protein has a molecular weight of approximately 17,000,000. The apparatus can also be used to test whether the virus is one molecular species, or a family of related proteins, and can be employed to purify a virus extract, without chemical treatment, with its ultimate loss of strength. The delicacy of this method should make it possible to study less sturdy viruses than tobacco mosaic, and should open a new avenue of investigation.—(*Nature*, Vol. CXL, No. 3545, p. 648, 1937.)

* * *

Cellulose from Carnauba Leaves.

Antonio Barreto has recently published in the *Revista de Chimica Industrial* the results of his experiments to obtain cellulose from the leaves of the carnauba palm tree, which is largely found in the northern states. He obtained 25 to 33 per cent. of cellulose from the leaves, after removal of the wax, dried in the air. Calculating that the production of carnauba wax amounts to about 15,000 tons yearly and that each leaf gives about five grams of wax, the northern states will handle about three billion leaves of carnauba, and 180,000 tons of cellulose can be obtained.

The cellulose was obtained by the Ritter-Kellner method, heating the leaves at 145° to 150°C. for 15 to 20 hours, as well as by the soda process using a four per cent. caustic soda solution, under a pressure of about six atmospheres for three to four hours. The Ritter-Kellner process gave better results. The cellulose obtained consists of fine fibres 3 mm. long.—(*Industrial and Engineering Chemistry, News Edition*, Vol. XV, No. 15, p. 339, 1937.)

* * *

Root Nodules of the Soy Bean.

A short account, by Chan Hsien Wu, of the strains of *Bacillus radicicola* from root nodules of the soy bean, is published in the report of the Institute of Scientific Research, Manchoukuo (1, No. 5, 139-162, 1937). Morphological and cultural characters are described, and the effect of the reaction of the medium upon growth has been investigated. The optimum reaction is about pH 6.5, though the organism will grow between the limits pH 3.7 and 7.8. Fermentation tests with various polyhydric alcohols, sugars and organic acid salts have been made; mannitol supported the best growths.—(*Nature*, Vol. CXLI, No. 3560, p. 167, 1938.)

TREND OF THE MARKETS.

[*The notes below are based principally upon running charts of the prices of the basic grades and upon general statistical information gleaned from contemporary publications and cablegrams and are intended to be a record of movements. An attempt is made, where possible to indicate the market outlook at the time of going to press, but no responsibility for the accuracy and subsequent truth of such observations is assumed. Unless otherwise stated the prices quoted are spot, London.*]

SUGAR:—Prices on the Home Markets have ranged as follows (c.i.f. per cwt.):—

	Foreign.	*Preferential*
	s. d.	*s. d.*
24th February ...	5 4½	9 0¾
3rd March ...	5 5¼	9 2¼
10th March ...	5 2¼	8 11¼
17th March ...	5 1½	8 10½
24th March ...	5 1½	8 10½
31st March ...	5 0	8 9¾
7th April ...	5 0	8 8¼
14th April ...	5 0	
(15*th April*, 1937) ...	6 6	10 3

There has been a gradual and almost uninterrupted decline in the price of raws which is attributed to disappointment at the absence of any announcement by the International Sugar Council, and to poor offtake for both raws and refined. Licht's estimate placing world consumption of sugar at about 400,000 tons below the free quota period and the free market outlet at a mere 3,000 tons more than in 1936/37, has also had a depressing effect on the market.

* * *

RUBBER.—Quotations for plantation sheet have ranged as follows:—

	Pence per lb.
23rd February	7 5-16
2nd March	7 1-8
9th March	6 15-16
16th March	6 13-16
23rd March	6 1-4
30th March	5 5-16
6th April	5 7-16
13th April	5 5-16
(14*th April*, 1937.) ...	11 1-8

Since our last report the market has been dull and easier. The sagging in prices has been attributed not only to the general disturbed state of the international situation on the continent but also to the poor outlook for consumption in the U.S.A. American consumption for February at 23,868 tons was particularly disappointing. A heavy increase in stocks was also recorded.

* * *

BANANAS.—The summer-like weather and the excellent quality of the fruit arriving from Jamaica has resulted in an all round improvement in the demand. Prices are firm at £17 10*s.* per ton delivered London and £17 5*s.* nearest Station Provinces. Brazilians are unchanged at £14 10*s.* delivered London and £15 10*s.* Provinces.—(*West India Committee Circular*, 24th March, 1938.)

* * *

COPRA.—The price of West Indian f.m.s. is unchanged at £12 5*s.* c.i.f. London. The market is dull.—(*West India Committee Circular*, 24th March, 1938.)

COCOA.—During the past month the holdup on the Gold Coast continued, but with the arrival there of the Commission, and as a result of meetings with the chiefs and farmers, it is persistently rumoured that an early resumption of shipments from Accra is expected. At the moment, therefore, markets do not afford much encouragement as every one is waiting to see what happens on the Gold Coast. The general feeling is that should these rumours prove true, the shortness in supplies from that point will soon be evened up. Accra is quoted at 32*s.* and locally Plantation cocoa is sold at $5.25 per fanega.—(*By Courtesy of the Cocoa Planters' Association of Trinidad, Ltd.*)

* * *

COTTON.—The following are the official spot prices in pence per lb. of the Liverpool Cotton Association.

	American Mid.	*Egyptian Gaza 7.*	*F.G.F. Sakel.*
25th February	5.21	7.78	8.58
4th March ...	5.13	7.65	8.60
11th March ...	5.06	7.48	8.43
18th March ...	5.10	7.41	8.36
25th March	4.97	7.24	8.19
1st April ...	4.91	—	—
8th April ...	4.79	—	—
16th April ...	4.89	—	—
(16*th April*, 1937)	7.47	10.90	12.05

Since our last report the upward movement in raw cotton prices has been checked and values once again are lower. Business has been unsettled by the European political situation and by poor advices regarding world consumption. In the U.S.A. about 93% of the farmers have approved of the Government's proposals for controlling acreage. There have been some enquiries for Sea Island and a few sales of Best Sea Island Cotton at 24*d.* have been made. Lower qualities have been neglected.

* * *

LIME PRODUCTS.—*Lime Oil.*—The value of Handpressed is unchanged at 32*s.* 6*d.* per lb. but business is slow. The demand for distilled has not improved to the extent expected and quotations are elastic. *Lime Juice.*—There is no demand for Concentrated and Raw is very quiet with the value nominally unchanged at 1*s.* 9*d.* to 2*s.* 3*d.* according to quality.—(*West India Committee Circular*, 24th March, 1938.)

* * *

COFFEE.—Latest quotations per cwt. include Santos, superior 29*s.*; Rio, No. 7, 20*s.*; Kenya, demand generally slow, ordinary bold sizes 50*s.* to 55*s.*, fine qualities up to 120*s.*; Costa Rica, liquoring properties poor and demand disappointing, bold size, country cleaned ranged from 53*s.* to 88*s.*, London cleaned 52*s.* to 118*s.*

CANADIAN NATIONAL (WEST INDIES) STEAMSHIPS, LTD.

WEST INDIA SERVICE

By the Fast and Luxuriously appointed Steamers "Lady Nelson," "Lady Hawkins" and "Lady Drake."

Fortnightly passenger and freight service from Halifax and St. John, N.B., all the year round to the British West Indies and British Guiana by the

R.M.S. "LADY NELSON," R.M.S. "LADY HAWKINS." R.M.S. "LADY DRAKE"

FROM MONTREAL during the Summer months and from HALIFAX during the Winter months a fortnightly passenger and freight service to Hamilton, Bermuda, Nassau, Bahamas and Kingston, Jamaica, by the

R.M.S. "LADY SOMERS," R.M.S. "LADY RODNEY"

The R.M.S. *Lady Nelson, Hawkins and Drake*, carry first, second and third class passengers; the *Somers and Rodney* first class passengers only.

Head Office: Messrs. Canadian National Steamships, 384, St. James Street, Montreal, Quebec.

Agents:

EASTERN ROUTE.

Hamilton, Bermuda	...Messrs. John S. Darrell & Co.
St. Kitts ...	...H. F. Wildy & Co.
Nevis ...	...Hugh F. Wildy.
Antigua ...	...Geo. W. Bennett Bryson & Co., Ltd.
Montserrat...	...W. Llewellyn Wall.
Dominica ...	...Curtis, Campbell & Co.
St. Lucia ...	...Peter & Co.
Barbados ...	...Gardiner Austin & Co., Ltd.
St. Vincent	...Corea & Co.
Grenada ...	...Geo. F. Huggins & Co., Ltd.
Trinidad ...	...Geo. F. Huggins & Co., Ltd.
Georgetown, B.G.	...Booker Bros., McConnell & Co., Ltd.

WESTERN ROUTE.

Hamilton, Bermuda	...John S. Darrell & Co.
Nassau, Bahamas	...R. H. Curry & Co.
Kingston, Jamaica	...Jamaica Fruit & Shipping Co.

HARRISON LINE

AND

HARRISON "DIRECT" LINE

LONDON, LIVERPOOL and GLASGOW to and from BARBADOS, TRINIDAD, DEMERARA, KINGSTON and WINDWARD and LEEWARD ISLANDS - - -

PASSENGER SERVICE to and from LONDON and WEST INDIES AND BRITISH GUIANA - - -
- S.S. *INKOSI* -
- S.S. *INANDA* -

London:
THOS. & JAS. HARRISON,
Dock House, Billiter Street, E.C. 3.

Liverpool:
THOS. & JAS. HARRISON,
Mersey Chambers.

WEST INDIES
Barbados —Da Costa & Co., Ltd.
Trinidad —G. F. Huggins & Co., Ltd.
Demerara—Curtis, Campbell & Co., Ltd.
Kingston —Arnold L. Malabre & Co.

AND

General Superintendent:
A. W. BADDELEY, ESQ., *Port-of-Spain, Trinidad.*

APPROACH THE PLANTER THROUGH THE DUAL ALLIANCE OF THE WEST INDIES - - -

TRINIDAD'S FORCEFUL 2

Trinidad Guardian

PUBLISHING DAYS
TUESDAY TO SATURDAY

Largest Circulation in the Colony

*

Sunday Guardian

Contains all the Features of a Modern Sunday Newspaper

For Specimen Copies, Advertising Rates, &c., Apply 22, St. Vincent Street, Port-of-Spain

For Rates, &c., Apply
London Office, 133, High Holborn, W.C. 1.
New York Office, S. S. Koppe & Co., Inc., 630 Fifth Avenue.

Three New Journals

Issued by the Imperial Council of Agricultural Research.

AGRICULTURE & LIVESTOCK IN INDIA
Issued bi-monthly
January, March, May, July, September and November.
Subscription.—Rs. 6 or 9s. 9d. *inclusive of Indian postage per annum in advance.*
Rs. 2 or 3s. 6d. per part *inclusive of Indian postage.*

THE INDIAN JOURNAL OF AGRICULTURAL SCIENCE
issued bi-monthly
February, April, June, August, October and December.
Subscription.—Rs. 15 or 24s. *inclusive of Indian postage per annum in advance.*
Rs. 3 or 5s. 3d. per part *inclusive of Indian postage.*

THE INDIAN JOURNAL OF VETERINARY SCIENCE & ANIMAL HUSBANDRY
Issued Quarterly.
March, June, September and December.
Subscription.—Rs. 6 or 9s. 9d. *inclusive of Indian postage per annum in advance.*
Rs. 2 or 3s. 6d. per part *inclusive of Indian postage.*

All communications regarding Subscriptions and Advertisements should be addressed, and all payments made to:

IN INDIA: The Manager, Government of India Central Publication Branch, P. O. Box 2078, Calcutta.

IN EUROPE & AMERICA: Public Department (Publications Branch), Office of High Commissioner for India, 'India House', Aldwych, London, W.C. 2.

PUBLICATIONS ISSUED BY THE IMPERIAL COLLEGE OF TROPICAL AGRICULTURE, TRINIDAD, B.W.I.

Journal.

"TROPICAL AGRICULTURE", the official monthly organ of the College. Vols. I to XIV (Vol. XV 1938, current Vol.).

Out of print :—Vol. I, Nos. 1, 5, 6 and 9; Vol. II, Nos. 1, 2, 3, 4, 8, 10 and 12; Vol. III, No. 1; Vol. IV, Nos. 1, and 2; Vol. V, Nos. 2 and 3; Vol. XIII, No. 7; Vol. XIV, No. 1.

Subscription Rates :—(British) 6*s*. ($1.44 Trinidad currency); (Foreign) 7*s*. 6*d*. ($1.80 Trinidad currency) per annum.

Back Numbers :—Vols. I to VIII (British) 1*s*. (Foreign) 1*s*. 1½*d*. per copy; Vols. IX to XV (British) 6*d*. (Foreign) 7½*d*. per copy.

Memoirs

	PRICE.
ECONOMIC SERIES:	
No. 1—The Sugar Industry of the British West Indies and British Guiana, with special reference to Trinidad, by C. Y. Shephard	1*s*.
LOW TEMPERATURE RESEARCH STATION:	
No. 1.—The Storage of Avocado Pears, by C. W. Wardlaw and E. R. Leonard	2*s*.
No. 2.—The Storage of Trinidad Citrus Fruits, by E. R. Leonard	2*s*.
No. 3.—The Storage of West Indian Mangoes, by C. W. Wardlaw and E. R. Leonard	2*s*.
No. 4.—Studies in Tropical Fruits, by C. W. Wardlaw and E. R. Leonard	1*s*. 6*d*.
No. 5.—Antiseptic and other Treatments in the Storage of Trinidad Citrus Fruits, by C. W. Wardlaw and E. R. Leonard *with Appendix*. Mycological Notes on Citrus Wastage by R. E. D. Baker.	2*s*. 6*d*.
No. 6.—Storage Investigations with Trinidad Citrus Fruits, 1935-36, by E. R. Leonard and C. W. Wardlaw.	2*s*. 6*d*.
No. 7.—Tropical Fruits and Vegetables: An Account of their Storage and Transport. By C. W. Wardlaw.	4*s*. 6*d*.
MYCOLOGICAL SERIES:	
No. 1.—Collar and Stem Canker of Pigeon Pea, caused by a species of Physalospora, by R. Leach and J. Wright	6*d*.
No. 2.—Control of the American Leaf Disease on Arabian Coffee in Trinidad, by H. R. Briton-Jones	6*d*.
No. 3.—Observations on Cypre in Trinidad with special reference to Canker Disease. *Part I*—Mycological, by H. R. Briton-Jones: *Part II*—Silvicultural, by R. C. Marshall	6*d*.
No. 4.—*Macrophomina Phaseoli* (Maub.) Ashby, in Trinidad. *Part I*—Parasitism, by J. West; *Part II*—Physiology, by W. R. Stuckey	1*s*.
No. 5.—A Further Preliminary List of Trinidad Fungi, by C. Thorold	1*s*.
SUGAR TECHNOLOGY SERIES	
No. 1.—Cane Syrup, by R. H. Hurst	6*d*.
No. 2.—Experiments with Final Molasses, by J. A. McDonald	6*d*.
No. 3.—The Sampling of Cane in the Field, by J. G. Davies	6*d*.

Reports.

	PRICE.		
PROCEEDINGS OF THE WEST INDIAN CONFERENCE OF AGRICULTURAL OFFICERS, 1930	2*s*.	THIRD ANNUAL REPORT ON CACAO RESEARCH, 1933....	5*s*.
FIRST ANNUAL REPORT ON CACAO RESEARCH, 1931....	1*s*.	FOURTH ANNUAL REPORT ON CACAO RESEARCH, 1934	5*s*.
SECOND ANNUAL REPORT ON CACAO RESEARCH, 1932	5*s*.	FIFTH ANNUAL REPORT ON CACAO RESEARCH, 1935	5*s*.
		SIXTH ANNUAL REPORT ON CACAO RESEARCH, 1936	5*s*.

STUDIES IN WEST INDIAN SOILS:

I and II	—*Out of print.*	
III	—The Cacao Soils of Tobago, by F. Hardy, G. C. Akhurst and G. Griffith	2*s*.
IV	—The Cacao Soils of Grenada, by F. Hardy, J. A. McDonald and G. Rodriguez	1*s*.
V	—The Sugar-cane Soils of Antigua, by F. Hardy, J. A. McDonald and G. Rodriguez	1*s*.
VI	—Some Soil Types of Jamaica, by F. Hardy and H. H. Croucher	2*s*.
VII	—The Cacao Soils of Trinidad (*a*) Montserrat District, by J. A. McDonald, F. Hardy and G. Rodriguez	2*s*.
VIII	—The Agricultural Soils of St. Vincent, by F. Hardy, C. K. Robinson and G. Rodriguez	2*s*.
IX	—Some Soil-Types of British Honduras, Central America, by F. Hardy, H. P. Smart and G. Rodriguez	2*s*.
X	—The Cacao and Forest Soils of Trinidad (*b*) South-Central District, by F. Hardy, D. W. Duthie, G. Rodriguez.	2*s*.

Miscellaneous Publications.

	PRICE.		
A NOTE BOOK OF TROPICAL AGRICULTURE, by R. C. Wood (*2nd Edition*)	5*s*.	RECENT IMPROVEMENTS IN THE SIMPLE CLARIFICATION FOR RAW SUGAR PRODUCTION, by J. G. Davies	2*s*.
ECONOMIC BOTANY OF CACAO, by E. E. Cheesman	1*s*.	SUGAR COST ACCOUNTS, by G. C. Skinner....	1*s*.
WILT DISEASE OF COCONUT PALMS IN TRINIDAD, *Part I*, by H. R. Briton-Jones	6*d*.	THE GIANT MOTH BORER OF SUGAR-CANE, by H. M. Skinner	6*d*.
WILT DISEASE OF COCONUT PALMS IN TRINIDAD, *Part II*, by H. R. Briton-Jones	6*d*.	THE STORAGE BEHAVIOUR OF LIMES, by C. W. Wardlaw	2*s*. 6*d*.

AGRICULTURAL LABOUR IN TRINIDAD, by C. Y. Shephard*	1*s*.
A NOTE ON THE VALUE OF CORRELATION AND REGRESSION IN STATISTICAL ANALYSIS, by D. D. Paterson*	1*s*.
FIVE YEARS OF CACAO RESEARCH, 1930-1934*	1*s*.
PRELIMINARY OBSERVATIONS ON THE STORAGE OF AVOCADO PEARS, by C. W. Wardlaw*	9*d*.
PRINCIPLES OF BANANA BREEDING, by E. E. Cheesman*	2*s*.
STUDIES IN TROPICAL LAND TENURE, by H. M. Leake*	2*s*.
THE CACAO INDUSTRY OF TRINIDAD, SOME ECONOMIC ASPECTS, *Parts I to V*, by C. Y. Shephard*	2*s*. 6*d*.
THE CACAO INDUSTRY OF TRINIDAD, SOME ECONOMIC ASPECTS, *Series II*, by C. Y. Shephard*	3*s*.
THE CACAO INDUSTRY OF TRINIDAD, SOME ECONOMIC ASPECTS, *Series III-IV*, by C. Y. Shephard	4*s*. 6*d*.

*Reprint.—A number of other reprints may be obtained on application.

The above publications are obtainable on application to the Editor, "Tropical Agriculture", Imperial College of Tropical Agriculture, Trinidad, B.W.I. (Whenever possible kindly send remittance in the form of a British Postal Order.)

Printed by the Government Printer, Trinidad, B.W.I.